THE "HERCULES DREDGERS" FOR THE PANAMA CANAL.

Through the courtesy of Mr. Charles Colné, Secretary of the American Commission of the Interoceanic Canal Company, and the Messrs. Slaven, President and General Manager of the "American Contracting and Dredging Company," we are enabled to give our readers the first published view of the most powerful dredging machinery as yet constructed in the world.

The following description is based upon the original contract plans and specifications and upon data furnished us by Mr. M. A. Slaven, the General Manager of the above-named company, and can therefore be relied upon as correct.

The general form and dimensions of the hull, and the arrangement of kelsons, etc., are shown on Plate 2. The hull is 100 ft. long, 40 ft. wide at after end, 60 ft. wide, 45 ft. from after end, and 29 ft. 3 in. wide at bow. The "slot" in which the buckets work is 36 ft. long and 6 ft. 7 in. wide. The height of hull is 12 ft. from bottom planking to top of deck at sides. The sides are built up as follows: The first course is 16 in. by 16 in., the second course 13 in. wide and 16 in. deep, the remaining timbers 8 in. by 8 in.; all of the timbers in the sides are securely fastened together by galvanized iron drift and through bolts. The entire hull is braced in all directions by strong knee-timbers, of natural crook. The sides of the "slot" are built up of timbers of the same dimensions, as those used in the sides of the hull. The bottom and end outside planking is 4½ in. thick, and the bottom floor is 2 in., and 3 in. plank. The bottom is sheathed with 20 oz. yellow metal, and otherwise well protected against the toredo. The hull is further strengthened by a longitudinal bulkhead, running the entire length, a cross-bulkhead, inclosing engine and boiler room near after end, and a second longitudinal bulkhead, extending from the cross-wall to forward end; all of these bulkheads are built of 12 in. × 6 in. timbers laid flat and well drift-bolted together.

The general arrangement and massive proportions of the frame-work supporting the hopper and upper shafting, and of the side-bracing and derrick-frames, will be seen from an inspection of Plates 1 and 2. The timbers used in the construction of frame-work and hull is first quality yellow pine.

One of the features especially worthy of notice in this new dredger, is the division of the "ladder" carrying the chain of buckets, into two sections, the upper one 60 ft. long, the lower one 40 ft. long. This "ladder" is hinged at the top with a 6-in. diameter pin, midway with a 7-in. pin, and at the bottom drum with an 8-in. pin, the pins passing through heavy castings. By the arrangement adopted, the lower section can be raised and lowered independently, and the hull and machinery, thus relieved of the enormous strain that would be put upon them, were this "ladder" in one piece, as is usual. The width of the ladder from out to out is 5 ft. The bottom section is lowered or lifted, by means of the heavy iron bales and the chain fall, shown in Plates 1 and 2.

The buckets, of which there are 38 in this machine, are strongly built of ¼-in. boiler iron, and are connected by an angle iron and bolts to the chain, in such manner, that they can readily be renewed. They hold, full, one cubic metre, or 1¼ cu. yards each. The bucket chain is made up of links, 36 in. long, from pin-centers, arranged two and one; they are made of horse-shoe iron; the single link carries the bucket, and is 8 in. wide, 1¼ in. thick, the double links are each 6 in. wide and 7-8 in. thick; the pins connecting the links are of steel 2½ in. diameter, and work in interchangeable gun-metal bushings, which may be easily replaced when worn out. The bucket-chain in ascending the ladder works upon rollers, set into the upper side of the ladder-frame as shown.

The hopper into which the buckets empty, is made of heavy boiler iron, and where it joins the cast-iron elbow of the discharging shute, is 5½ ft. in diameter. The shute itself is of boiler iron, is 3 ft. in diameter throughout and 150 ft. long; it is supported entirely from the masts shown, by the 1 in. wire cables, which latter can be adjusted by turn-buckles.

Under ordinary circumstances, water sufficient to carry the dredged material to the end of shute, would be raised with the buckets; but for working in tenacious clay, etc., two powerful 10-in. pumps will supplement this supply, forcing the water up a 7-in. pipe, and delivering it at will, either into the bottom of elbow, the top of the hopper, or by attaching a nozzle directly into the bucket to be emptied.

Separate engines are provided to drive the bucket machinery, handle the "bucket ladder," raise and lower the spuds, and to pull out sunken logs or snags. Three tubular boilers, each 60 in. in diameter and 16 ft. long, furnish the steam; the boilers themselves are supplied with water by a nest of surface condensors containing 1,400 tubes 5½ ft. long.

Two engines of 100 H.-P. each are located in the after end of the hull and drive the main belt, which is of rubber, 36 in. wide, and runs over the pulleys *C* and *B* (Plate 1.) The driving pulley *C* is 10 ft. in diameter, the driven pulley *B* is 8 ft. in diameter. Each have a 38-in. face. By a system of gearing, shown on Plate 2, the pulley *B* operates the bucket drum, the shaft of which is 10 in. in diameter and 17 ft. long.

Two 8 in. × 12 in. engines, 40 H.-P. each, are stationed at *G* (Plate 1), and are used exclusively for handling the bottom adjustable section of the "bucket-ladder." These engines are controlled from the deck. At *H* (Plate 1) are two engines, also 8 in. × 12 in. each, which raise and lower the spuds and work the gypsy-winches *M M*, (Plate 2.) Two other 8 in. × 12 in. engines are placed on deck at *J* (Plate 1), and are employed in pulling out snags and sunken logs in advance of the dredging buckets. Chains from these last engines pass over sheaves (one shown at *K*, Plate 2) on the derrick frame or over large sheaves on the bows, not shown on plans, for this snag pulling business. The engines at *J*, by means of the sheave *L* (Plate 1) can also be used for changing the position of the upper section of the bucket ladder when occasion would require it.

Each dredger is furnished with two spuds, made of Delaware white oak, each 60 ft. long and 24 in. in diameter, with heavy chisel-point casting on lower end. The spud-pipes are of cast iron, 2 in. thick, 25 in. inside diameter at middle, 27 in. diameter at top and bottom; they are 12 ft. 10 in. long, and solidly built in with timbers, as shown on general plan of hull. The main or "pivot-spud," as we may call it, is located exactly on the center line of hull, about 27 ft. from after end, the "shifting-spud" is on a line with it, across the hull, but 18 ft. to left of center line, or that much nearer the port-side of the hull, the purpose of this arrangement we shall explain hereafter.

An inclined wooden shute is shown on Plate 1, leading from the end of the "slot" to the hopper, the sides of this shute or trough are 2 in. plank, the bottom is 3 in. plank, protected by boiler iron; its purpose is to protect the deck and machinery from the drippings of the buckets, and also to serve as a guide to the returning line of buckets in deep dredging.

The amount of material which the "Hercules" dredger can raise per hour will, of course, depend very much upon the nature of the soil in which the excavation is carried on; but supposing the buckets to be filled each time, its maximum capacity for work may be estimated as follows: The driving pulley *C* (Plate 1) is calculated for a speed of 60 revolutions per minute, this motion passing through the gearing above is reduced to 9 revolutions per minute of the "bucket-drum" shaft, which is equivalent to 18 buckets, or 18 cubic metres, or 24 cubic yards per minute; this would be 1,440 cubic yards per hour, or in a working day of 10 hours 14,400 cubic yards, an enormous quantity of material to be displaced by one machine in the time given. The largest dredger used on the Suez Canal only handled 2,200 cubic yards per day, so that allowing a very heavy discount from this maximum duty, as the measure of a fair day's practical work, the "Hercules" will still be far in advance of any previously built dredge.

The three dredgers now being built for the Panama Canal, are especially designed for canal-making. In working them, one will follow the other, the first one cutting a channel 100 ft. wide and about 9 or 10 ft. deep. No. 2 will follow and deepen this channel to about 19 ft., the third will complete the 27 ft. 6 in. depth of water which the contract requires: the full width of the canal will be taken out afterward.

The method of operating one of these huge dredgers is ingenious and may be described as follows: being intended for canal work, the two shores are depended upon for anchorage. The cutting is made across the canal in a circular sweep, from the "pivot-spud" as a center, the "shifting-spud" being raised while the dredging is going on. To move the hull to the right and left, about the center-spud, there are four sets of shore lines arranged as follows: on each side of the hull, on a line with the two spuds are heavy swivel-blocks, and two lines, one on each side, pass from some secure fastening on the shore through these blocks, and then forward to the two gypsy-winches, at *M M* (Plate 2); two other lines, one from each winch, pass forward to the lower section of the "bucket-ladder," through another swivel-block fastened to the eye-bolt *N* or *N'*, on either side of the "ladder," and then to the two shores. This arrangement brings the lateral motion of the hull under the complete control of the men at the winches. The forward motion of the whole machine, to make a fresh cut, is accomplished by dropping the "shifting-spud" while the bow of the dredger is still hauled hard over to the right-hand bank of the canal (facing the bow), the "pivot-spud" is now raised, and the hull hauled over towards the left, the machine meanwhile revolving on the secondary-spud, until the "pivot-spud" is again over the axial line of the canal, when it is dropped, the "shifting-spud" raised, and all is ready for the new excavation. An advance of 20 ft. can be made by this manœuvre.

To work one dredger, a crew of seven men is employed, consisting of captain, engineer and fireman, and four helpers. This is exclusive of any men who may be stationed on the sides of the canal to handle the shore lines.

The "Hercules" was designed and patented by Horace B. Angell, C. E., and H. H. Lynch, and the machinery of the present dredgers, as well as of those previously made on this design, comes from the shops of the "Golden State & Miner's Iron Works," in San Francisco, California. The hull and general frame-work of the three Panama dredgers is being built by Doughty & Kapella, in Philadelphia; one of them is completed, and will depart for Panama about Feb. 10 next. The "American Contracting & Dredging Company," of which Mr. H. B. Slaven is President, and Mr. M. A. Slaven, General Manager, and for whom these three dredgers are being built, at a cost of $125,000 each, now have the contract for dredging that section of the Panama Canal lying between Colon and Gatun, a distance of a little over seven miles.

The "Hercules" is not an untried machine, for one of about two-thirds the power of the one we illustrate, but on the same general design, was built and used two years ago in California, by Gen. Thomas H. Williams. This first machine cut a canal through Union Island in the State named, 3 miles long, 80 ft. wide, and 12 ft. deep, in 82 working days of 8 hours each, this machine was put to the severest possible test by the Messrs. Slaven, with the view of discovering its weak points before building the Panama dredgers.

GAS COMPANY FOR WASHINGTON.—The House Committee on the District of Columbia have agreed to report favorably the bill to incorporate the United States Gas and Fuel Company of the District of Columbia.

EUREKA SPRINGS R. R.—This new road has been finished to Eureka Spring, Ark., and the depot will soon be completed.

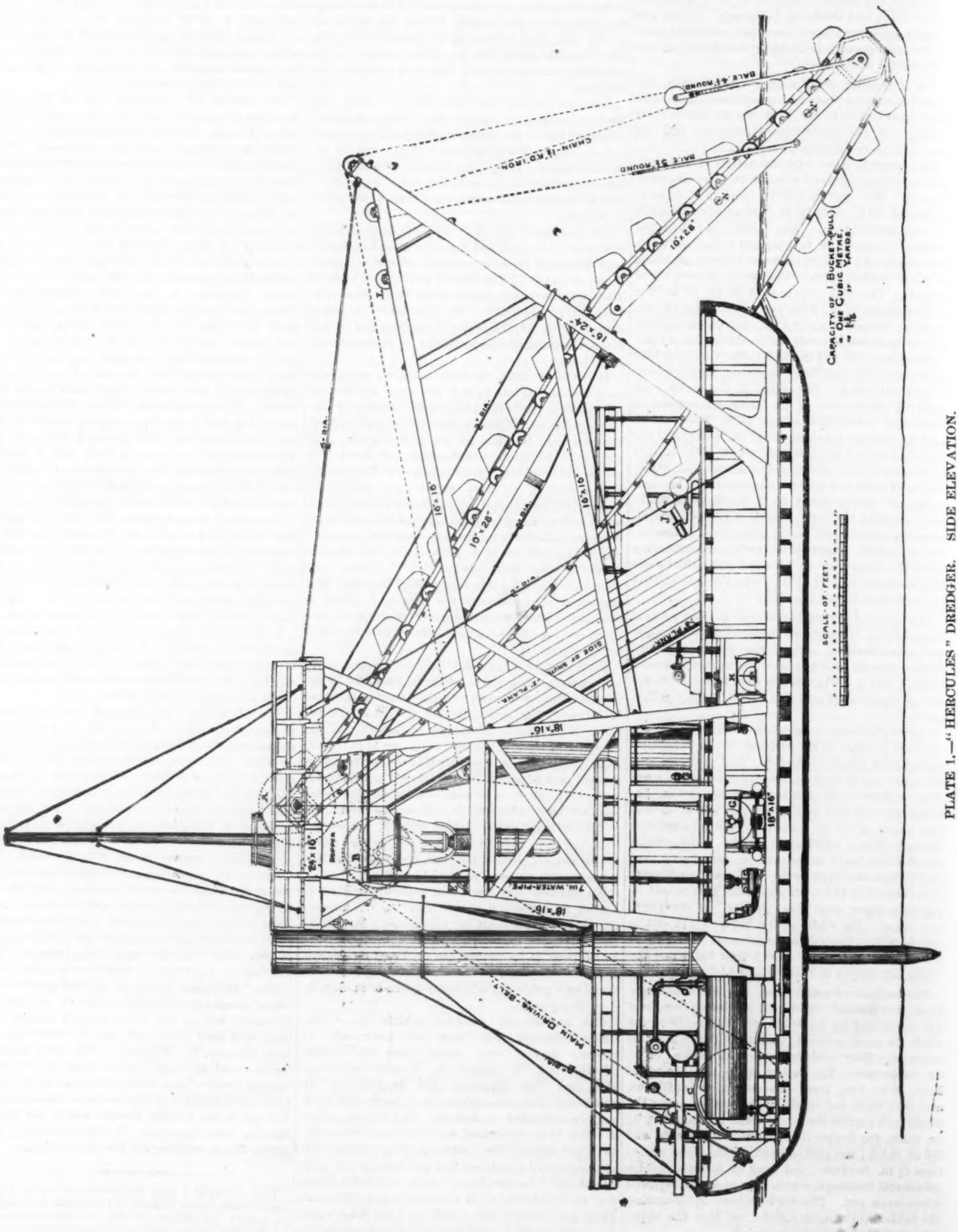


PLATE 1.—"HERCULES" DREDGER. SIDE ELEVATION.

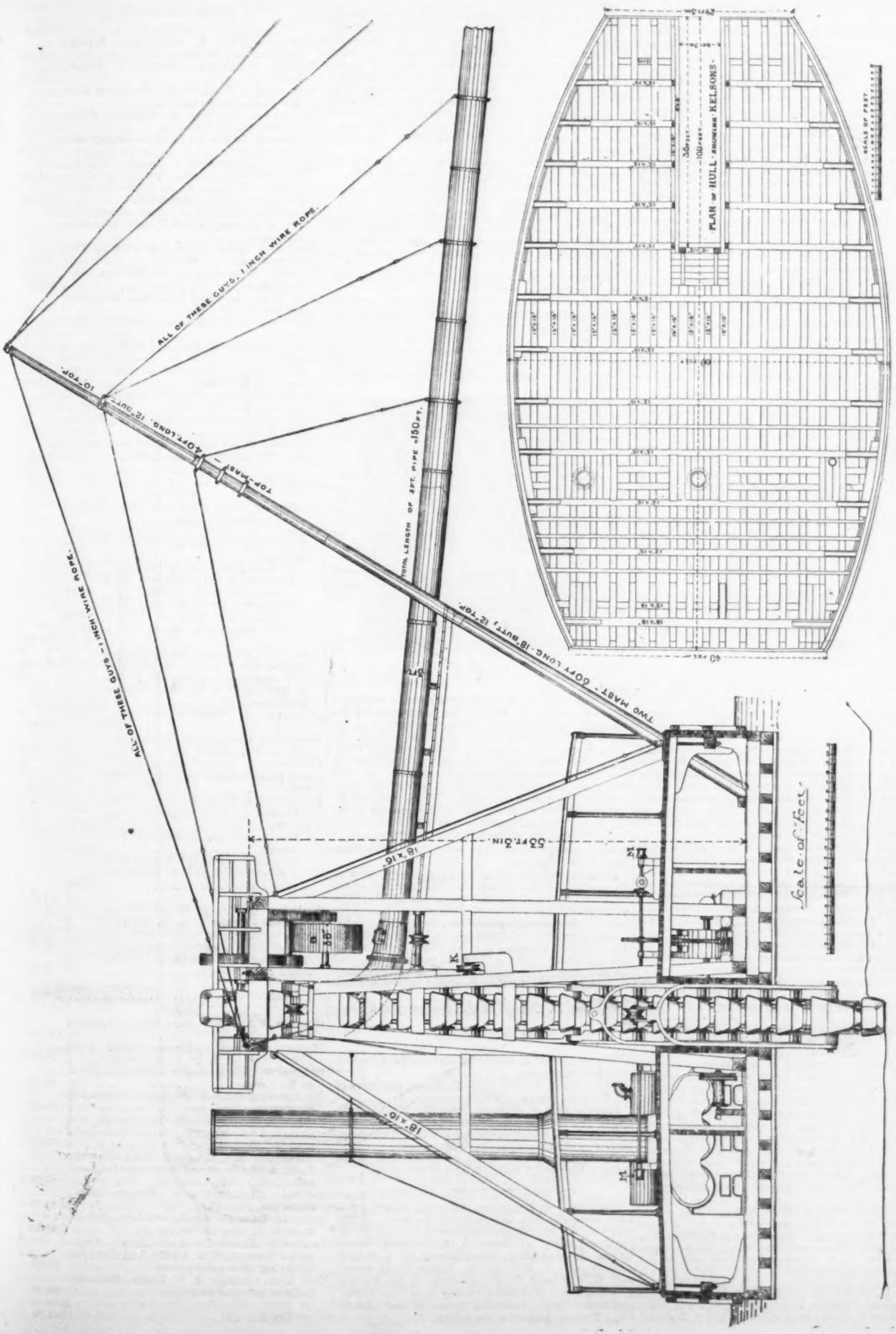

ALL OF THESE GUYS, 1 INCH WIRE ROPE.
40FT. LONG. 12" BUTT.
10" TOP.
TOP-MAST
TOTAL LENGTH OF 8FT. PIPE =150FT.
TWO MAST - 60FT LONG. 18" BUTT, 12" TOP.
ALL OF THESE GUYS, 1 INCH MANILA ROPE.
PLAN of HULL SHOWING KELSONS
SCALE OF FEET
53Ft.3In.
18"x16"
Scale of feet

PLATE 2.—"HERCULES" DREDGER. FRONT ELEVATION AND PLAN OF HULL.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 40.)

CCCCLXXV.—ELLENVILLE, N. Y.

Ellenville, New York, in lat. 41° 42′ N., long. 74° 17′ W., is in a valley at the foot of the Shawangunk mountains, on the line of the Delaware & Hudson canal.

Water-works were built by a private company in 1870 after plans of Theodore Weston, C. E., taking the supply from a small stream in the Shawangunk Mountains, which is impounded by a dam of earth across a gorge, forming a storage reservoir 140 ft. above and half a mile from the village.

Distribution is by 3⅝ miles of cast-iron pipes of from 8 to 4 in. diameter, with 40 fire hydrants, 21 gates and 177 taps.

The population in 1880 was 2,750. The daily consumption is not known.

The works cost $35,000. The expenses in 1882 were $584.00 and the receipts $976.62.

George A. Dudley is Secretary of the company.

CCCCLXXVI.—LEAVENWORTH.

Leavenworth, Kansas, in lat. 39° 18′ N., long 94° 57′ W., on the Missouri River, is on ground varying from 30 to 130 feet above the river, and surrounded by a semicircular range of hills rising to an elevation of 350 feet.

It was settled and incorporated a city in 1854.

Water-works were built by a private company in 1882 after plans of Galen W. Pearsons, C. E., taking the supply from the Missouri River. The water is first pumped by vertical plunger pumps, of 3,600,000 gallons daily capacity, into settling reservoirs 100 feet above the river. After settling, it is pumped into a reservoir 216 feet in diameter and 18 feet deep, holding 5,000,000 gallons, situated on Pilot Knob 350 feet above the river.

Distribution is by 13 miles of cast-iron pipes of from 18 to 4 in. diameter, with 81 fire hydrants. The number of taps is not given, the works being just finished. The city pays $75 per year for each hydrant. Wrought-iron and cast-iron service pipes are used.

The population in 1880 was 16,546.

The works cost $300,000. The bonded debt is $250,000 at 6 per cent. interest.

L. T. Smith is President and D. M. Swan Secretary of the company.

CCCCLXXVII.—LITTLE ROCK.

Little Rock, Arkansas, in lat. 34° 40′ N., long. 92° 12′ W., is on rolling ground on the Arkansas River. The rocky cliff on which the city stands, and from which it derives its name, is 50 ft. above the river.

It was settled in 1820.

Water-works were built for a private company in 1878 by Travers Daniel, taking the supply at first from the Arkansas River and pumping by two Blake pumps of 30-in. steam and 14-in. water cylinders of 24-in. stroke into a plate-iron stand pipe 20 ft. in diameter and 100 ft. high, on ground 65 ft. above the river. The water can also be pumped directly into the mains.

In 1881 the suction pipe of the pumps was carried across the river and the supply taken from a well.

Distribution is by 8½ miles of cast-iron pipe of from 14 to 4 in. diameter, with 85 fire hydrants and 60 gates. The number of taps is not given. The city pays $85 per year for each hydrant. Service pipes are of lead and wrought iron.

The population in 1880 was 13,138.

No statistics of consumption or of the cost of the works are given.

The works are principally owned by Col. Zeb. Ward.

CCCCLXXVIII.—PAINESVILLE, O.

Painesville, Ohio, in lat. 41° 45′ N., long. 82° 15′ W., on Grand River, 3 miles from Lake Erie.

It is on a plateau about 100 ft. above Lake Erie.

Water-works were built by a private company in 1882, after plans of Benjamin F. Stephens, taking the supply from wells, of which no description is furnished, and pumping it by two Worthington Duplex pumps, each of 1,000,000 gallons daily capacity, with an iron tank 20 ft. in diameter and 76 ft. high, on ground 50 ft. above the pumps.

Distribution is by 6 miles of cast-iron pipes, of from 12 to 4 in. diameter, with 50 fire hydrants and 25 gates. The works went into operation in December, 1882. The city pays $60 per year for each fire hydrant.

Service pipes are of wrought iron.

The population in 1880 was 3,841.

The capital stock of the company is $150,000.

The works have cost $100,000. There is no bonded debt. C. A. Avery is President, and B. F. Stephens the Superintendent.

CCCCLXXIX.—LEXINGTON, KY.

Lexington, Virginia, in lat. 37° 50′ N., long. 79° 21′ W., is on irregular ground on the North Branch of the James River, at the end of the James River and Kenawha Canal.

It is the seat of Washington and Lee University. Settled in 1735, it was incorporated in 1778. Water-works were built in 1832 by the city, taking the supply from springs which are collected in a reservoir 25 ft. in diameter and 15 ft. deep, holding 55,080 gallons, and built in stone and brick laid in cement. It is 265 ft. above the river and 62 ft. above the highest point on Main street of the city.

Distribution is by three miles of 3-in. cast-iron pipe, with 9 fire hydrants, 10 gates and 400 taps.

The population in 1880 was 2,878. The daily consumption is 50,000 gallons.

The cost of the works it not known. The expenses in 1882 were $300, and the receipts $74.

Joseph B. Holmes is the Superintendent.

CCCCLXXX.—SANTA CRUZ, CAL.

Santa Cruz, Califoirna, in lat. 37° 00′ N., long. 121° 55′ W., is on the San Lorenzo River. The business part of the city is on flat ground, surrounded by an elevated plateau occupied by residences.

Settled by the Spaniards in 1719, it was incorporated as a city in 1856.

Water-works were built by a private company in 1876, after plans of Edgar M. Morgan, taking the supply from two creeks, the Branciforte, east, and Majors, west of the city, the water from which is conveyed to two small reservoirs excavated in chalk rock and lined with rubber walls 3 feet thick. They hold 650,000 gallons at 100 feet above the city.

Distribution was at first by wooden pipe made in Washington Territory, but it was not successful and has been replaced by riveted wrought iron. There are 18 miles in use of from 12 to 4 in. diameter, with 45 fire hydrants and 500 taps. The city does not pay for fire hydrants. Service-pipes are of wrought iron. The population in 1880 was 3,898. The daily consumption in 1882 was 250,000 gallons. The works cost $100,000 and the repiping $80,000. The bonded debt is $50,000 at 8 per cent. interest. The annual expenses are $3,000 and the receipts $9,600. G. F. Bowman is Secretary and W. H. Duke, Superintendent of the Santa Cruz Water Company.

There is another company supplying water to the city, styled the Santa Cruz Water-Works, of which F. A. Hilm is owner and manager, and from which no returns have been received.

CCCCLXXXI.—POTTSVILLE, PA.

Pottsville, Pennsylvania, in lat. 40° 41′ N., long. 76° 12′ W., on the Schuylkill River, is on hilly ground, rising 200 ft. from the river.

It was settled in 1800, and incorporated as a borough in 1831.

Water-works were built by a private company in 1826, taking the supply from a spring in the borough, the water of which was furnished by gravity to pipes laid in the principal streets. In 1854, water was brought 4 miles through 12-in. pipe from Wolf Run to a distributing reservoir in the town, which holds 5,000,000 gallons. In 1875 a storage reservoir was built on Eisenhuth Run, formed by an earthen dam 1,350 ft. long, 35 ft. high and 40 ft. wide on top, with slopes of 2 and 1½ to 1. This reservoir covers 70 acres and contains 300,000,000 gallons at 600 ft. above, and 8 miles from the town. The conduit-pipe is of cast iron, 12-in. diameter.

Distribution is by 35 miles of cast-iron pipe of from 16 to 3 in. diameter. The number of fire hydrants and gates and taps is not given. The town does not pay for public water. Service pipes are of lead and galvanized iron.

The population of Pottsville in 1880 was 13,346. The company supplies also St. Clair, Port Carbon and Palo-Alto, making the total population served about 25,000. The capital stock of the company is $200,000. No further financial statements are given.

William D. Pollard is the Secretary and Engineer.

(TO BE CONTINUED.)

The receipt of statistics as follows is acknowledged with thanks:

From James A. Bell, City Engineer, statistics of St. Thomas, Ontario, Water-works.

From Joseph B. Holmes, Superintendent, statistics of Lexington, Va., Water-works.

From C. A. Avery, President Water Company, statistics of Painesville, O., Water-works.

From N. Spofford, C. E., statistics and water rates of Haverhill, Mass., Water-Works.

IOWA CITY & DIAGONAL RAILWAY COMPANY.—This company was incorporated in Iowa on the 27th ult., capital, $2,000,000; incorporators, S. B. Patterson, J. C. Cochran, J. C. Shroder, Moses Bloom, Richard Long, Jacob Ricord, W. S. Schell, John Seydell, S. W. Lee, F. Tullos, C. D. Goodrich, H. S. Fairall, C. F. Lovelace, S. H. Fairall, J. J. Holmes. The line proposed is to run south east from Clinton, touching Iowa City and Ottumwa. Place of business, Iowa City.

TRACK LAID IN 1882.

Middle Western States.

OHIO.	Miles.
Alliance, Niles & Ashtabula — Alliance Junction n. e. to Niles	26.00
Chicago & Atlantic—Marion to Indiana line	81.00
Cincinnati & Northern (N. G.)—Avon Junction to Zoological Gardens	3.25
Cincinnati, Van Wert & Michigan—Pleasant Point n. to Paulding	6.00
Cincinnati & Eastern (N. G.)—Irvington to Cedar Fork	12.50
Cincinnati, Columbus & Hocking Valley—Between Jefferson and Clayville Junction	8.00
Cleveland, Delphos & St. Louis (N. G.)—Pendleton to Mt. Blanchard	23.00
Columbus & Hocking Valley—Snow Fort Br. of Monday Creek Br.—Orbiston to Murray	2.00
Connotton Valley (N. G.)—Straitsville Div.—Canton s. w. to Bartlett	50.00
Indiana, Bloomington & Western—Bet. Springfield and Ind. line	45.00
New York, Chicago & St. Louis—Laid during the year in Ohio	50.95
Ohio Central—Corning s. e. to Point Pleasant	44.00
Ohio Southern—Jackson n. e to Wellston	10.00
Toledo, Cincinnati & St. Louis (N. G.)—Southeastern Extension—Berlin—(2 m. south of Wellston) s.	25.00
Toledo & Indianapolis—Toledo s. 19—Findlay n. to Van Buren, 7	26.00
Valley—Canton south to Wheeling & Lake Erie Junction	17.25
Wheeling & Lake Erie—Bellevue n. to Toledo, 52—Massillon s. to Zoar	71.00
Total	500.95

MICHIGAN.		
Chicago & West Michigan—New Buffalo south to Indiana Line		2.00
Chicago & North-Western—Menominee River Br. completed to Crystal Lake and branches	7.57	
Do Iron Extension & branches	21.24	
Escanaba & Lake Superior R. R. completed with branches	38.04	
Peninsula division main line, branches to mines	4.20	
Other branches to mines	15.35	
		86.40
Cincinnati, Wasbash & Michigan—Indiana line n. e. to Benton Harbor		34.00
Grand Rapids & Indiana—(G. R. Ind. & Mackinaw R. R.), Bay View to Mackinaw City	34.11	
Manistee Br.—Luther to Cary's	2.82	
		36.93
Marquette, Houghton & Ontonagon—Branches to mines		8.75
Ontonagon & Brule River—Extended to a point 20 miles east of Ontonagon		12.00
Port Huron & North-Western (N. G.)—Branch to East Saginaw completed	10.00	
Port Austin Br.—Minden to Port Austin	31.00	
Almont Division (Pt. Huron & S. Western R.R.)—Port Huron w. to Almont	33.00	
		74.00
Saginaw, Tuscola & Huron (N. G.)—Of the 37 miles from E. Saginaw n. e. to Sebewaing laid in 1882		14.00
Tawas & Bay County—Tawas City e.		4.00
Toledo & South Haven (N. G.)—Lawrence to Hartford		6.50
Total		278.58

INDIANA.	
Chicago & Atlantic—Ohio line to Indiana line	147.00
Chicago & Great Southern—Oxford n. to Fair Oakes, on L. N. A. & Chicago	40.00
Chicago & West Michigan—Michigan line s. to La Crosse	36.00
Cincinnati, Wabash & Michigan—Goshen n. to Michigan line	20.00
Evansville & Terre Haute—Mt. Vernon Br. Completed by extending from Cynthiana s. to Mt. Vernon	24.80
Indianapolis & Chicago Air Line (Now br. L. N. A. & Chi. Ry.) Delphos to Indianapolis	73.00
Indiana, Bloomington & Western—Newcastle e. to Ohio line	33.00
Indianapolis & Evansville—Washington on O. & M. R. R. s. to Petersburg	16.00
Louisville, Evansville & St. Louis—Completed between New Albany and Oakland by laying in several places	65.00
New York, Chicago & St. Louis—Between Indiana line and Ohio line	90.00
Total	544.80

ILLINOIS.

Belleville & Carondelet—Belleville e. to Mississippi River		17.00
Danville, Olney & Ohio River—West Liberty s. to Olney		9.00
Chicago, Burlington & Quincy (Joliet, Rockford & Northern R. R.) Paw Paw to Sheridan Junc	19.68	
East Clinton n. to Fulton	2.00	
		21.68
Chicago & Evanston—near northern limits of Chicago		2.00
Chicago, Milwaukee & St. Paul—Suburban branch from Galewood near Chicago		2.67
Chicago & Western Indiana—Extension to Hammond	7.54	
Branches in South Chicago, etc.	2.64	
Belt Railroad—Chicago & Alton Crossing n. C. & N-W Crossing	4.85	
		15.00
Fulton County (N. G.)—London Mills e. to Galesburg		15.00
Illinois Central—Kankakee & S-W. Coal Branch—Buckingham to Essex	9.52	
South Chicago Br.—70th to 92d St.	4.50	
		14.02
Indiana, Illinois & Iowa Reddick w. to Streator 31: Momence e. 6		37.00
Jacksonville & Southeastern—Litchfield s. to Smithboro		29.50
New York, Chicago & St. Louis—Indiana line n. to Grand Crossing		10.00
Peoria & Farmington—Farmington w. to Phelp's Station		34.00
St. Louis, Jerseyville & Springfield—Elsah to Grafton		3.00
St. Louis Coal R. R.—Harrison n. to Pinckneyville 20—Branch to Murphysboro 2		22.00
Toledo, Cincinnati & St. Louis (N. G.) Ridge Farm w		150.00
Total		381.87

WISCONSIN.

Chicago & Northwestern—Trempeleau to Galeville		6.53
Chicago, Milwaukee & St. Paul—In Beaver Dam, 2.10; in Prairie du Sac, 1.04		3.14
Chicago, St. Paul, Minneapolis & Omaha—Superior Br.—From 9 m. n. of Superior Junct. n. w. to Superior	51.43	
Chip. Falls & N. Ry., Bloomer n. w. to Chicago Junct	56.60	
Northern Division, Cable n	81.00	
		189.63
Chip. Valley & Superior—Eau Claire s. to Minn. line	45.50	
Menominee Br.—Up Cedar River to Cedar Falls	21.40	
		66.90
Green Bay, Winona & St. Paul—Br. Plover to Stevens Point		5.90
Markesan & Brandon (now branch C., M. & St. P.) Brandon to Markesan		11.50
Milwaukee & Northern—Wisconsin & Mich. R. R.—From 2 m. south of Stiles, north		14.00
Milwaukee, Lake Shore & Western—Summit Lake n. to Sec. 32. T. 38, R. 11	27.40	
Monico Junct. to Rhinelander	15.60	
Florence Div.—Antigo n. e. to Bryant	5.00	
		48.00
St. Paul Eastern Grand Trunk—Oconto w. to Stiles Junct		10.33
Wisconsin Central—Neenah s. e. to Schleisingerville	65.00	
In Ashland to new terminus	1.00	
		66.00
Total		371.33
Total five Middle Western States		2,077.53

—*Railway Age.*

GALOPS RAPIDS IMPROVEMENT, ON THE ST. LAWRENCE RIVER.

The improvement of the channel through Galops Rapid, seven miles east of Prescott, Ont., is without doubt the most important work in connection with the betterment of the St. Lawrence and the enlargement of the canals now in progress.

It is at this point that the first obstruction to the deep-water channel between Kingston and Montreal is met with. At present vessels can only load with safety to a 9 ft. draught-line; it is intended to increase this depth to 14 ft. This improvement will require a cut through hard rock, 1,200 ft. long, 200 ft. wide, and of an average depth of 4 ft.; amounting to about 35,000 cubic yds. of rock. The current at this point has a velocity of 8 miles per hour, adding to the difficulties to be surmounted.

The contract was awarded to Wm. Davis & Sons, of Ottawa, who afterwards sublet the work to E. E. Gilbert & Sons, of Montreal, the latter party commenced operations in Sept., 1880. To facilitate the work, the Messrs. Gilbert built in Montreal the drill boat "Torpedo." This is a scow 85 ft. long, 22 ft. beam; it is fitted up with machinery for moving it, and appliances for running four drills; it was put to work in July, 1882. During the season of 1882 4,000 cubic yds. of rock were dredged, and a large quantity blasted, and yet to be dredged. Three and one-half tons of dynamite were used in this one season.

CORRESPONDENCE.

LOCATING CURVE.

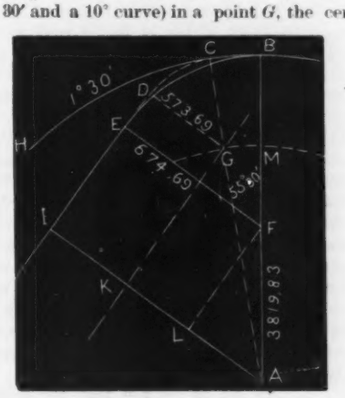
WINNIPEG, Man., Jan. 14, 1883.

EDITOR ENGINEERING NEWS:

DEAR SIR: The January 6th number of your valuable paper contains a question about the locating of a curve. A solution of the problem may be found in the following few considerations:

Be *A* the center of the 1° 30′ curve and *EI* the given tangent to the 8° 30′ curve *EB*, *F* being the center of the latter curve.

A parallel line *KG* to tangent *EI*, at a distance *IK* equal to the radius of a 10° curve, will intersect the circle *MG* (with its center in *A* and a radius equal to the difference between the radii of a 1° 30′ and a 10° curve) in a point *G*, the center



of the 10° curve, which compounds at *C* into *EB* and ends tangentially at *D*.

It is now very easy to calculate *BC* and the length of the 10° curve.

Draw *AI* parallel *EF*, and *FL* parallel *EI*, and you will have:

$$AI = AL + LI = AF \cos. 55° 30′ + EF$$
$$= 2{,}456.12$$

$$AK = AI - IK = 2{,}456.12 - 573.69 = 1{,}882.43.$$

We made $AM = AG = 3{,}819.83 - 573.69 = 3{,}246.14$ and get therefore:

$$\cos. GAK = \frac{AK}{AG} = \frac{1882.43}{3246.14},$$

that is angle $GAK = 54° 33′ =$ angle *CGD*, and the length of 10° curve, $CD = 545.5$ ft.

Angle $BAC = 55° 30′ - 54° 33′ = 57′$, which gives: Distance $BC = 63$ ft. and finally $ED = KG - FL = 52.6$ ft. Yours respectfully, V. WEBER.

[Correct solutions, but by different methods, are also received from Prof. P. H. P., of Iowa University; A. B., of Walton, Kan.; E. B. M., Blairsville, Pa.; J. H. M., South Pueblo, Col.; R. P. A., Greensboro, N. C.—ED. ENG. NEWS.]

LIFE OF CAST-IRON PIPES.

LOUISVILLE, KY., Jan. 25, 1883.

EDITOR ENGINEERING NEWS:

In your valuable paper of January 20th, is published a card signed "Nassau," in which the writer suggests further information in several particulars in the very important statistics now being published in your paper by J. James R. Croes, M. Am. Soc. C. E. In no one item would information be of more value than upon the quality or kind of street mains in use by our several cities and water companies. In the cost of a water-works the street mains are about one-half the value of the total cost of construction; hence the great importance of ascertaining any additional information under that head. It is, perhaps, well known that there are several kinds of pipe being used, and it is not the purpose of this note to advocate or recommend any particular kind; but the experience of water companies, and cities under this head, would be of great value, and doubtless be the means of greater security and economy to future water-works. All of which is respectfully submitted to yourselves and to Mr. Croes.

SAFETY.

THE GLOUCESTER WATER-WORKS.

NEW YORK, Feb. 1, 1883.

EDITOR ENGINEERING NEWS:

Please explain the circumstances under which an injunction was obtained in the matter of the Gloucester, N. J., Water Company, and oblige, yours respectfully, SUBSCRIBER.

[We cannot explain it. We first saw the notice in a New York evening paper; next day telegraphed to Gloucester for particulars, but were informed by postal card that no information was to be had. We published the item; but in the following week received the advertisement which we publish. We have no further knowledge of the matter.—ED. ENG. NEWS.]

ANNUAL CONVENTION COUNTY SURVEYORS OF INDIANA.

The county surveyors met in annual convention on January 16, in the court-house at Indianapolis. The following delegates were in attendance: W. A. Osmer, Cass county; J. C. Pulse, Decatur; R. I. Morrison, Henry; L. S. Alter, Jasper; Isaiah Piatt, Lagrange; F. M. Parker, Greene; R. R. Spencer, Rush; R. H. Walls, Putnam; Charles Webster, Shelby; H. B. Fatout, Marion; C. E. Rogers, Jay; E. H. Streadling, Delaware; F. B. Wood, Jackson; M. L. Thompson, Montgomery; H. Grubb, Parke; S. Hiatt, Morgan; F. W. Barton, Wells; Henry Wagner, Huntington, and E. F. Cottingham, Hamilton. The President, W. A. Osmer, delivered an able address in which he strongly urged the necessity of a general officer to be known as Surveyor-general. The corresponding secretary read correspondence out of which grew discussion of drainage under the new enactment of the Circuit Court. The subject of locating interior section corners was exhaustively canvassed. Messrs. Spencer, Fatout, Pratt and Parker were appointed committee on legislation. At the evening session R. I. Morrison delivered an address on "The Degree of Accuracy to be attained by County Surveyors."

WHAT AN UNBALANCED BID LED TO.

A motion for a mandamus to compel Controller Campbell to deliver to Charles Jones a warrant for $9,835.26, drawn in C. Jones's favor and signed by the Mayor and Controller, was denied on Jan. 31st by Judge Barrett, in Supreme Court Chambers. Jones, as the assignee of James W. O'Grady, who had obtained the contract for the work, built a sewer in One Hundred and Thirty-ninth-street, west of Third avenue. His vouchers were approved by the Department of Parks, which had charge of the work, and the warrant was drawn and signed upon faith in this approval. After the warrant had been returned to him by the Mayor Controller Campbell was informed that the contract was based upon fraud. His informant was E. B. Van Winkle, the chief engineer of the Department of Parks, who said that the original contractor, J. W. O'Grady, was the son of Cornelius O'Grady, an engineer of the Park Department, who made the estimate of the quantity and character of work required to be done in the construction of the sewer, and who stated in his preliminary estimate, that only 10 cubic yards of rock would have to be excavated. Young O'Grady, in his bid, proposed to do the rock excavating for $50 a cubic yard. His competitors bid from $5 to $7, but in other respects he underbid them, and the aggregate of his bid was smaller than [illegible] of the others. In the course of the work 297 cubic yards of rock were cut through. At $50 a yard the sum due the contractor for this rock work was $14,850, part of which the city has paid. In their affidavits, in opposition to the motion for a mandamus, Controller Campbell and Engineer Van Winkle assert that a reasonable compensation for the rock excavating would be between $750 and $1,100. The statements on the affidavits were not denied on behalf of Jones. Judge Barrett, in denying the motion, said that fraud is reasonably to be inferred from the papers before him, but he gives contractor Jones leave to renew his motion upon papers designed to do away with the suspicion of fraud.

BRIDGE ACROSS THE SABINE RIVER, TEXAS.—A charter has been granted to J. H. Newson, of Mineola, to build a toll bridge across the Sabine. It will be two miles long, and cost $12,000.

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.
Tribune Building, New York City.

The Engineering News Publishing Company, Proprietor.
GEO. H. FROST, Treasurer.

SATURDAY, FEBRUARY 3, 1883.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe and Mexico, $5, payable in advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

Terms of Advertising.—One inch, 12 lines, one insertion, $2; one month, $6.50; three months, $17; six months $30; one year, $50. Special rate for large space and long time will be given on application. Advertisements inserted for less than three months, payable in advance; for longer time, payable quarterly.

Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belong to the province of this journal is solicited.

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FOR information on subjects personal to this journal, see Publishers Department, Page III. Advertisements.

CHANGE IN AN OLD FIRM.—The firm of BENJAMIN PIKE'S SON & CO., importers and manufacturers of optical and mathematical instruments, 928 Broadway, has changed its name to that of BENJAMIN PIKE'S SONS. The house was established in 1804 by BENJAMIN PIKE, SR., and during the many years of its existence has maintained its reputation for making instruments of marked excellence.

ASSOCIATION OF ENGINEERING SOCIETIES.—The journal of this Association for December, 1882, contains a paper by J. A. L. WADDELL, on Details of Ordinary Iron Bridges; a paper on the Dynamo-Electric Machines, by Prof. A. L. AREY; and a paper on Excavating Wet Material by Hydraulic Process, by J. T. DODGE. The numbers of this journal are 30 cents each, and are for sale by H. G. PROUT, 12 Barclay street, New York, to whom all orders must be addressed.

SURVEYING INSTRUMENTS.—Messrs YOUNG & SONS, of 43 N. 7th St., Philadelphia, who are well known as makers of first-class engineering instruments, have called our attention to the omission of their name as being represented at the Columbus and Lansing meetings of the surveyors. The reports sent us were hastily made up by the Secretaries of the Associations, and we printed them with very little alteration. Full reports of all these meetings will be published in pamphlet form hereafter, when we hope to give due credit to all parties who contributed to their success. Among these the instrument-makers very properly take a prominent place, as it is to their attentive study of the wants of the profession coupled with ingenious designing and accurate workmanship that much of the success of practical surveying is due. One of the good results of these numerous meetings of intelligent surveyors and engineers must be the improvements of instruments (if such there can be) brought about by the close comparison of the productions of various manufacturers.

THE PROFITABLE USE OF EXHAUST STEAM.

Indicator cards taken from engines in operation often reveal a back pressure on the return stroke which reduces the effectiveness of the steam pressure on the forward stroke and increases the quantity of steam required to perform a given amount of work for conditions otherwise the same.

The back pressure may occur because the exhaust ports were improperly proportioned when the engine was built, and can be overcome only by reconstructing the ports; it can occur from the improper setting of the valves and is then easily remedied by their proper adjustment; or it may be caused entirely by having the exhaust pipe itself too small to carry off the steam promptly, and is then easily removed by substituting a larger pipe. In many cases, however, it is caused intentionally by the consumers who propose using the exhaust steam for other purposes, as heating the feed water for their boilers, for drying, for heating rooms, and many other purposes.

It is a well known fact that the exhaust steam contains nearly as much heat as it possessed before it performed its work in the engine. 2,564 heat units represent the theoretical amount of heat consumed by a horse-power for one hour, whereas it requires from 30,000 to 60,000 heat units to change water of ordinary temperature into steam of the necessary pressure to generate one-horse power for an hour in a non-condensing engine, being from twelve to twenty-four times the theoretical amount required for the power developed; the difference between 2,564 and the above figures is approximately the heat in exhaust steam which is available or goes to waste. It is a knowledge of this fact which induces users of steam to utilize the exhaust steam for other purposes where heat is required of a lower temperature than that of the exhaust steam itself, thus making use of an agent which would otherwise go to waste. It can and ought to be used at a profit, but is often unknowingly utilized at an actual loss to the consumers, who suppose they are making a gain.

To illustrate, let us assume that the exhaust steam is used to heat the feed water for the boiler which supplies the engine with steam. We will suppose that the amount of surface in the heater is so small that the exhaust steam at atmospheric pressure will not raise the feed-water to the desired temperature. The consumer helps himself out of the difficulty by choking the exit of the steam from the heater and increasing the back pressure.

There is a certain back pressure below which the coal required to generate the extra steam needed because of the back pressure, is less than the extra amount which would be necessary if there were no back pressure, and the exhaust steam were not used to heat the feed water; there would, therefore, be a saving arising from such use of the exhaust steam. If the back pressure reached this amount, then the quantity of coal to generate the extra amount of steam required because of the back pressure would be equal to that which would be required to heat the feed water, to the extent that it would be heated by the exhaust steam; there will then be neither gain nor loss by using the exhaust. If the back pressure exceeded this point, then it and the use of the exhaust steam are a positive detriment; it would be more profitable to obviate the back pressure, and heat by other means.

Calculations made show that the greatest limit in the use of exhaust steam under pressure occurs in ordinary boilers and engines, and this limit is in direct proportion to the amount of heat which is imparted to the feed water; when it is heated from freezing to boiling-point, *the limit within which back pressure can be allowed, and yet a saving of coal be affected by using the exhaust steam to heat the feed water, is one-sixth of the absolute terminal pressure in cylinder if engine is operated without back pressure.*

If it is desired to use the exhaust for other purposes, the limit of back pressure for the given case can be determined in the same manner, by determining the amount of heat necessary to perform the given duty, and reducing this heat to pounds of coal, and then determining how much steam this coal could generate; this amount can be easily reduced to pounds pressure in cylinder, and will then represent the allowable back pressure, below which the exhaust steam can be used to advantage in effecting a saving in the consumption of coal.

From the above it is seen that there is a gain in using the exhaust steam under pressure, which, within certain limits, overbalances the loss caused by working the engine with back pressure, and that this gain increases with the reduction of the back pressure. This gain can be reduced to pounds of coal actually saved. By proper attention to details, the exhaust steam can be used as before described, and yet any increase in the back pressure be avoided. The gain then reaches a maximum. It is attained by having the exhaust ports of proper proportions, and by providing exhaust pipes of ample size to readily carry away the steam and for heating feed water, by providing a sufficient surface in the heater to heat the water to the desired temperature, by means of the steam when at atmospheric pressure.

The same conditions are necessary when the steam is used for heating rooms, for drying, and for other purposes. Plenty of radiating surface is required, and it is the work of the engineer to determine the dimensions and amounts of surface and other relating questions. The consumer who will employ a competent engineer to determine all such questions for him in his steam plant, will often derive a direct benefit every year in the saving in his coal bill alone, which will repay him many times for the expense incurred by him for the service of such an engineer.

FOREIGN ENGINEERING PROJECTS.

LONDON, Jan. 8, 1883.

The year which has just passed away has been a busy one in almost all branches of engineering. Although there is not now so much work on hand as at the beginning of last year the very numerous bills in Parliament for the 183 session give promise of plenty of work. The number of bills lodged is 276, of which 138 are railway, 34 tramway, 26 water, gas and lighting, 6 road and bridge and 3 canal bills. The numerous applications for provisional orders for electric lighting will also furnish engineering work of an important kind. While considerable railway work is to be executed in India and Australia, hopes are entertained that engineering enterprise in Egypt will be much extended. Amongst railways which are about to be built in the colonies is that which is to connect Brisbane with Fort Davidson (Gulf of Carpentaria), the length of railroad to be constructed being about 1,000 miles. This line is to be finished in 7½ years, and is to be constructed on the land grant system.

Two important tunnels are now in course of construction in this country, the Severn and the Mersey tunnels. The former is rapidly progressing, and when completed will allow the Great Western Railway Company to undertake the carrying of a large coal trade direct from South Wales to London. The length of arch already turned is 7,000 feet, the progress of late averaging 500 feet per month. Four shafts are used for extending, three for mining and pumping, and four for pumping only. The water raised daily by 20 pumps is nearly 12,000,000 gallons. The total length of the tunnel will be 4½ miles long, 2½ under the river Severn and 2 under land. The brick work is executed in vitrified Cattybrook, or Staffordshire bricks set in Portland cement. 26,000,000 bricks are used per year, and 3,000 men employed.

The Mersey tunnel is also progressing vigorously, a total of 800 yards having already been driven through red sandstone. The length to be completed under the Mersey is, however, only three-quarters of a mile. Colonel Beaumont's machine, the same as is used for boring the heading of the Channel tunnel, is to be employed.

A good deal of discussion has lately been caused by bridge failures. There are so many bridges in this country built over twenty years

ago which are no longer so strong as when they were built and were intended for the traffic of the day, that the subject is one of great importance and a strict inspection and recalculation of their strength would be most advisable. The railway viaduct in the Kinzua Valley (New York, Lake Erie & Western Railway) is severely criticised by English engineers as being too light, and nothing more than a monster wire frame which might collapse during a heavy wind.

The most important railway now being constructed in England is undoubtedly the Tower Hill extension—forming the completion of the Metropolitan underground railways in London. The line to Tower Hill was completed lately, and now the last link—the line from Tower Hill to Cannon street and the Mansion House station. Few of the hundreds of thousands passing along the busy thoroughfare of Cannon street are aware that the houses on both sides are being underpinned, while the street is only a plank floor under which the railway tunnel side walls are being built, and the arches completed by over 400 men working by gaslight. The underpinning is of cement concrete, widths of about 4 feet being worked at a time. In a few months the line is to be completed, and it will be possible to go direct by underground railway from Liverpool street in the city, to Westminister.

The isthmus of Corinth Canal is stated to be making rapid progress. The earthwork is alluvial material, about 300,000 cubic yards being moved per month, mostly by the aid of Priestman's excavators and dredgers. The total estimated quantity of earthwork is about thirteen million cubic yards, about a million of which is dredging, and one million seven hundred thousand earth and rock, semi-hard, and one million of rock below water.

In English engineering circles the Canal project between the Mediterranean and the Red Sea in rivalry of the Suez canal is strongly advocated. It would not only be important as a ship passage but also for immigration purposes. The project is that of a sweetwater canal fed by the Nile, and would involve the removal of over 160 million cubic yards of material, which is about double of that of the Suez canal proper. For Egypt the canal would be of inestimable value An area of about 500,000 acres in the province of Behera and of 1,000,000 acres in the province of Oborkieh and Dakalieh could be irrigated in connection with it.

A good many tramways are being constructed throughout Great Britain, and the American system of wire rope action tramways is this year to be tried on the Highgate line, for which ground will be broken this week. A company under the Limited Liability Act is now being formed in London for acquiring the right of Halladie's Patent Cable System for the United Kingdom. The capital is to be £1,000,000 in 100,000 shares of £10 each. The object of the company, which has a most respectable board of directors, is to grant licenses on royalties, lease, work and construct tramways.

Ship-building has been progressing during the past year on a most extensive and lucrative scale. The ocean steam trade has been very prosperous, more particularly that between England and America. This is easily shown by the example of vessels like the Alaska, Gallia, etc., the earnings of which each voyage are computed at about £20,000, of which about £5,000 is profit.

TESTS OF PIN-ENDED COLUMNS.

THEODORE COOPER.

The report of Col. Laidley to the Ordnance Office of tests made at the Watertown arsenal upon the large government testing machine Aug. 31st, 1881, contains a valuable series of tests made upon columns furnished by the Detroit Bridge and Iron Co.; besides a few tests made upon Phœnix columns; one steel column from the Glascow bridge and one wrought iron column from the Kellogg Bridge Co.

As all of these latter (except the one of steel) are square-ended columns we will not at present consider them; but will confine our remarks to the 58 columns, with two pin-ends, of the Detroit Bridge Co.; the most complete series of tests upon pin-ended columns yet published. They are all formed upon the same general plan, channels with the flanges facing outwards, connected at the ends by side plates and latticed with diagonal bars from one end to the other. The pin-holes are perpendicular to the webs of the channels—the webs being thickened with plates at the pin-holes.

We have compiled and condensed the data given in the detail report of the tests into the accompanying table, column one of the table gives the original test number, column two, the ratios of the length of the column (center to the center of pins) to the least dimension, which, in all cases, is the width of the channels; column three, the ratios of the length to the least radius of gyration r of the column. The other columns give, consecutively, width of channels; distance apart of channels; spacing of the lattice bars; dimensions of the lattice bars; dimensions of the side plates at the ends of the columns; number and thickness of the pin-hole plates upon each channel; diameter of the pins; ultimate strain per square inch of cross section of the columns; and the mode of failure of the column at its ultimate point of resistance.

We have not been able to fill out all the data from the report, as it is very deficient in positive dimensions. We have had to depend upon the context, and general similarity of the different series, to check our conclusions as to the correct dimensions; some that we are in doubts about, have been marked with (?).

Columns 1,123 and 1,124 are said to have same details as 1,110, excepting side-plates; but as 1,110 has been omitted, apparently by an oversight, from the volume, we are in the dark as to its true dimensions; we presume, however, as the columns have been tested in pairs, 1,110 to be a duplicate of 1,109. In some of the tests of the columns, cast-iron separators are mentioned, and partly illustrated in one of the columns; but we are not told which of the columns have these separators, and at what points they are located, except that they are mentioned once as being at the ends of the column, and in another place as being at the center of the column. The general form of the ends of the columns is a *peculiar* one for pin-connected columns, as we cannot conceive how tension bars can be attached to the pins with the side-plates in the position as shown. (See Figure.)

As the strength of columns as well as all built structures, depends so largely upon the details, we are largely in the dark, what these columns would stand if the side-plates were removed to a point nearer the center of the column, as in practice would have to be the case.

We are able, however, to deduce certain conclusions of general interest in regard to the strength of latticed columns, and which may serve as guides to those who are designing columns for general use or for further column tests.

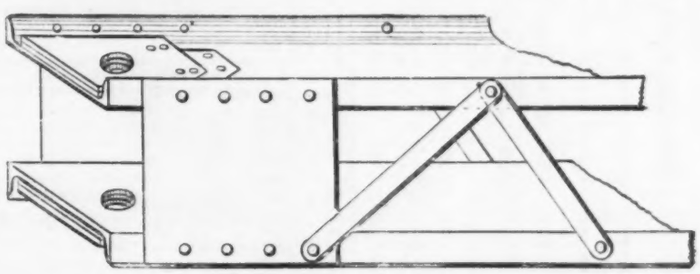
1st. By an examination of the mode of failure of the columns, we see that a large number of them failed by the bucking of the channels between the points of attachment of the lattice bars. This method of failure is shown more upon the columns of low diameters, as might be expected. For, as the columns decrease relatively in length, they stand a higher strain per square inch as a whole, but the portion of the channel between the points of attachment of the lattices will only stand a definite amount: an amount which is exceeded by the column strain in the shorter columns but not by that of the larger columns.

Columns of short lengths (relatively) should therefore be more closely latticed than those of long lengths.

It will also be seen from our table that many of the columns which failed by buckling of the channels between the points of attachment, failed by this buckling taking place at or near the ends of the columns.

This is undoubtedly due to two different reasons: first, any unequal distribution of the load applied at the pins upon the two channels will produce a greater effect at the ends than further towards the center of the column; secondly, the latticing, usually of the same size throughout the column, is subject to greater strains at the ends of the column due to the deflecting tendency. These strains upon the end lattices by producing an increased elongation and compression of the lattice bars, allow a greater amount of local flexure in the individual channels, and hence more liability to buckling.

The *ends of the columns should therefore be made more rigid.* This may be done by using



GENERAL FORM OF COLUMN END. FOR DIMENSIONS SEE TABLE.

longer and thicker side-plates at the ends with close riveting, or by use of moderate-sized side-plates (not less than two diameters of the column in length), and heavier or more lattices at the ends. The proper spacing of the lattice-bars is a matter of great importance; it has been generally considered that the proper maximum distance should be such that the channel-bar, considered as a separate column of a length equal to the spacing, ought to be of equal compressive strength to the column considered as a whole. If the lattice bars are sufficiently strong and stiff to keep the points of attachment rigid, this might be approximately correct. This is rarely the case.

In the experiments before us, we find buckling of the channels taking place far inside of the limits as determined by the above rule. 12-inch channels, 48 inches long, tested alone, stood a compressive strain of 36,000 lbs. per square inch; yet the columns made of the same channels buckled, with spacing 22 inches long, at a compressive strain of 31,600 lbs. 10-inch channels, 48 inches long, stood 34,000 lbs., but the columns buckled at less than this strain, with spacing of 22 inches.

We must, therefore, keep far inside of the distance as above mentioned; the best distance for each case being dependent largely upon the details of the connections, dimensions of the lattice bars, etc. It will be noticed that in these experiments two different sized pins have been used, 3½ and 3-inch diameters. It will also be noticed that the columns with 3-inch pins give much lower results than those of the same relative lengths with the larger sized pins. This would be very positive evidence of the influence of the size of the pins upon the resisting power of the columns, as has long been our individual belief, but that most of these 3-inch pin columns are noted as having initial bends. From the test numbers as well as the arrangement of the tests in the volume it appears that numbers 1—29, 463—470, and 1107—1232 represent series of tests made at different times. That the series 463—470,

EXPERIMENTS ON PIN-ENDED COLUMNS MADE AT WATERTOWN ARSENAL, LATTICED CHANNEL COLUMNS DETROIT BRIDGE CO.

Test, No.	Ratios. $\frac{l}{d}$	Ratios. $\frac{l}{r}$	Width of channel.	Distance between channels.	Spacing of lattices.	Size of lattices.	Dimensions of side plates.	Number and thickness of pin-hole plates.	Diameter of pin.	Ultimate strain per square inch.	Mode of failure.
			Inch.	Inch.	Inch.	Inches.	Inches.	Inches.	Inch.		
17	10	27	12	8	22	2¼×⅝	15×¼	2, ¼	3⅛	25,070	Buckling of channels near end of column.
1,109	10	27	12	8	22	2¼×⅝	15×¼	2, ¼	3⅛	33,420	" " " " "
15	15	40	12	8	22	2¼×⅝	15×¼	2, ¼	3⅛	33,830	" " " " "
16	15	40	12	8	22	2¼×⅝	15×¼	2, ¼	3⅛	35,490	" " " " "
13	15	41	10	8	22	2 ×⅝	12×¼	2, ¼	3⅛	35,550	Failed by direct compression.
14	15	41	10	8	22	2 ×⅝	12×¼	2, ¼	3⅛	35,450	Buckling of channels near end of column.
469	20	52	12	6	18	2¼×⅝	23×¼	4, ½	3	28,970	By deflection in line of pins; column had an initial bend of 0.24 inches in that direction.
1,111	20	53	8	8	18	2 ×⅝	15×¼	2, 7-16	3⅛	34,810	Buckling of channels.
1,112	20	53	8	8	18	2 ×⅝	15×¼	2, 7-16	3⅛	35,240	By deflection perpendicular to axis of pins.
11	20	55	10	8	22	2 ×⅝	15×¼	2, ⅜	3⅛	33,840	Buckling of channels over whole length.
12	20	55	10	8	22	2 ×⅝	15×¼	2, ⅜	3⅛	34,000	" " " "
9	20	56	12	8	22	2¼×⅝	18×¼	2, ⅜	3⅛	34,360	" " near ends.
10	20	56	12	8	22	2¼×⅝	18×¼	2, ⅜	3⅛	36,610	" " " "
1,107	24	61	6	8	18	2 ×¼	12×¼	1, ½	3⅛	34,740	By deflection perpendicular to axis of pins.
1,108	24	61	6	8	18	2 ×¼	12×¼	1, ½	3⅛	34,160	" " " "
1	25	64	6	8	18	2 ×¼	15×¼	1, ½	3⅛	35,880	" " " "
2	25	64	6	8	18	2 ×¼	15×¼	1, ½	3⅛	32,380	" " " "
470	25	65	12	6	18	2¼×⅝	23×¼	4, ½	3	30,000	By deflection perpendicular to axis of pins; column had a very small initial bend in this direction.
467	24	66	10	6	18	2 ×⅝	23×¼	3, ½	3	29,980	By deflection perpendicular to axis of pins.
1,113	25	67	8	8	18 ?	.....	.....	.....	3⅛ ?	33,970	" " " "
1,114	25	67	8	8	18 ?	.....	.....	.....	3⅛ ?	33,610	" " " "
7	25	67	12	8	22	2¼×⅝	15×¼	2, ⅜	3⅛	32,940	Buckling of channels near ends.
8	25	67	12	8	22	2¼×⅝	15×¼	2, ⅜	3⅛	34,240	" " " "
3	25	69	10	8	22	2 ×⅝	18×¼	2, ⅜	3⅛	33,880	" "
4	25	69	10	8	22	2 ×⅝	18×¼	2, ⅜	3⅛	33,060	Deflected diagonally.
1,231	30	77	6	8	18	2 ×¼	12×¼	1, ⅜	3⅛	33,820	Deflected perpendicular to axis of pins.
1,232	30	77	6	8	18	2 ×¼	12×¼	1, ⅜	3⅛	32,380	" " " "
1,115	30	80	8	8	18	2¼×⅝	15×¼	2, 7-16	3⅛	32,180	" " " "
1,116	30	80	8	8	18	2¼×⅝	15×¼	2, 7-16	3⅛	32,140	" " " "
28	30	80	12	8	22	2¼×⅝	18×¼	2, ⅜	3⅛	31,610	Buckling of channels near ends.
29	30	80	12	8	22	2¼×⅝	18×¼	2, ⅜	3⅛	31,340	Deflected perpendicular to axis of pins.
465	30	80	8	6	16	.....	23×¼	2, ½	3	27,750	" " " "
5	30	83	10	8	22	2 ×⅝	15×¼	2, ⅜	3⅛	34,130	" " " "
6	30	83	10	8	22	2 ×⅝	15×¼	2, ⅜	3⅛	31,930	" " " "
468	30	83	10	6	18	2 ×⅝	23×¼	3, ½	3	32,000	Deflected perpendicular to axis of pins; column had an initial bend of 1 inch in this direction.
1,229	35	89	6	8	18	2 ×¼	18×¼	1, ⅜	3⅛	32,750	Deflected perpendicular to axis of pins.
1,230	35	89	6	8	18	2 ×¼	18×¼	1, ⅜	3⅛	31,120	" " " "
1,123	35	93	8	8	22 ?	.....	12×¼	.....	3⅛ ?	32,230	" " " "
1,124	35	93	8	8	22 ?	.....	12×¼	.....	3⅛ ?	31,370	" " " "
26	35	96	10	8	22	2 ×⅝	18×¼	2, ⅜	3⅛	32,180	" " " "
27	35	96	10	8	22	2 ×⅝	18×¼	2, ⅜	3⅛	29,380	" " " "
466	37.5	100	8	6	16	.....	23×¼	2, ½	3	26,000	" " " "
463	40	102	6	6	16	2 ×¼	23×¼	1, ½	3	25,000	" " " "
1,117	40	102	6	8	18	2 ×¼	15×¼	1, ⅜	3⅛	29,180	Deflected perpendicular to axis of pins; weakened by separators.
1,118	40	102	6	8	18	2 ×¼	15×¼	1, ⅜	3⅛	30,990	Deflected perpendicular to axis of pins.
24	40	107	8	8	18	2 ×⅝	15×¼	2, ⅜	3⅛	31,350	" " " "
25	40	107	8	8	18	2 ×⅝	15×¼	2, ⅜	3⅛	27,850	" " " "
1,119	45	115	6	8	18	2 ×¼	12×¼	1, ⅜	3⅛	30,590	" " " "
1,120	45	115	6	8	18	2 ×¼	12×¼	1, ⅜	3⅛	31,050	" " " "
22	45	120	8	8	18	2 ×⅝	12×¼	2, ⅜	3⅛	24,850	" " " "
23	45	120	8	8	18	2 ×⅝	12×¼	2, ⅜	3⅛	26,920	" " " "
1,121	50	128	6	8	18	2 ×¼	18×¼	1, ⅜	3⅛	23,350	" " " "
1,122	50	128	6	8	18	2 ×¼	18×¼	1, ⅜	3⅛	25,360	" " " "
464	50	128	6	6	16	2 ×¼	20×¼	1, ½	3	15,280	Deflected perpendicular to axis of pins; initial bend of 0.3 inch.
20	55	141	6	8	18	2 ×¼	15×¼	1, ⅜	3⅛ ?	21,850	Deflected perpendicular to axis of pins.
21	55	141	6	8	18	2 ×¼	15×¼	1, ⅜	3⅛	20,810	" " " "
18	60	154	6	8	18	2 ×¼	12×¼	1, ⅜	3⅛	14,740	" " " "
19	60	154	6	8	18	2 ×¼	12×¼	1, ⅜	3⅛	15,900	" " " "

? Indicates that dimensions are not given, but are probably as given in table.

which are those having 3-inch pins, should be the only ones having initial bends noted (as carefully as 0.08 inch in a length of 12 feet) is rather explained by the possibly greater care of the experimenter at that time, than by the belief that the fifty other columns of the other series had no bends as small even as 0.08 inch.

For the above reason we are inclined to think the lower test results of the columns with small pins were largely, if not entirely, due to the size of the pins. The difference in the action of round-ended, pin-ended and square-ended columns under compressive strains, can only be due to the relative amount of resistance to rotation of the column ends; this resistance for rounded end columns would be practically nothing; for columns with pin ends it would depend upon the frictional moment at the circumference of the pin, and would therefore be a factor of the size of the pin and the closeness of the fit of the pin in the pin-holes; for square-ended columns it would be the moment due to decentralizing of the load upon the ends of the columns and throwing it toward one corner of the column. We do not propose reducing these tests into the form of a formula, for we hope to have a more extensive series of tests in the near future, from which a much more reliable formula can be determined.

It is to be hoped that our manufacturers and bridge builders will give us complete series of columns with different sized pins.

And it would also be very instructive could we have a series of tests made with rounded ends; not so much for any practical benefit derived from tests of such columns, but that they would be interesting as comparisons for the tests upon pin and square-ended columns.

In addition it would be very desirable to have tests upon columns of higher diameters than to the extent of the present series of tests—in order to determine the law of flexure of the columns.

Cannot this be accomplished by a series of tests upon light struts such as are used for lateral or wind struts of bridges?

In the report upon tests of Phœnix columns made at the Watertown arsenal, we were told that "lattice columns after deflecting slightly, suddenly gave way by tearing out the riveting of the lattice bars, after which but little strength as a column remains." This remark was made before any well made lattice columns had been tested. In the present series of tests, all of lattice columns, we find no remarks indicating the failure of a single lattice bar, though the columns have deflected not slightly but considerably.

In test 1,113 we find that the column after being deflected 0.4 inch by the ultimate load of 254,100 lbs., was still able to sustain 230,800 lbs. = 30,800 lbs. per square inch; col. 1,119 after deflecting 4.3 in. under the ultimate load of 159,800 lbs. sustained 57,900 lbs. = 12,700 lbs. per square inch; col. 1118 after deflecting 3.5 in. under the ultimate load of 143,500 lbs., sustained 66,700 lbs. = 14,400 lbs. per square inch.

These tests show that lattice columns when well made have a considerable reserve of strength even after being severely strained. The fact has no other bearing than that, a column, which we would not load in practice over one quarter of its ultimate strength, could in emergencies, sustain that load temporarily even after it was considerably damaged.

It is important that every data connected with the form and mode of manufacture of the columns, and most minute information in regard to the manner of testing and the action of the columns under the tests and the condition after failure, should be noted.

The additional cost of printing and illustrating fully these tests will be a mere bagatelle to the waste of money in testing carelessly a series of expensive columns. An observer at a testing machine should endeavor to note everything that may enable those who afterwards read the reports to understand thoroughly the whole process.

PERSONAL.

WM. L. BILLIN, Mining Engineer, died this week suddenly of pneumonia. He was lately engaged at Maysville, Chaffee Co., Colorado.

LOW-REED.—On Tuesday, January 23, 1883, at the residence of the bride's parents, by the Rev. J. A. Kribbs, Mr. Emile Low, of Pittsburgh, and Miss Estelle Reed, of Zelienople.

MR. J. W. SHIPMAN, formerly an Engineer of the New York Bridge Company, is now engaged with the Wrought Iron Bridge Co., of Canton, Ohio, and will represent that company in New York with office in Room 89, Tribune Building.

RUDOLPH HERING, Sanitary Engineer, 18 Tribune Building, New York, has been engaged by the City of Wilmington, Del., to prepare plans and specifications for a system of sewerage for that city. Mr. HERING has already completed his surveys and is now engaged on the plans, which he expects to submit with report within a few weeks.

A. R. ROBERTS, C. E., formerly Assistant Engineer on Philadelphia & Reading Railroad, has been appointed Assistant Commissioner of Highways in Philadelphia, Pa. Mr. ROBERTS is a son of the late SOLOMON ROBERTS, Chief Engineer of the North Pennsylvania Railroad, and who was one of the most widely known civil engineers of his time.

OBITUARY.

CHARLES EDWARD FOWLER, City Engineer of New Haven, Connecticut, died on Sunday, the 28th ult., of erysipelas in the head, after an illness of nine days.

Mr. FOWLER was born in Woodbridge, Conn., February 6, 1841, but soon after his birth his parents removed to New Haven, and it was there that Mr. FOWLER obtained his education and spent the greater portion of his life.

Upon the breaking out of the rebellion he enlisted in Company G, Twentieth Connecticut Volunteers; was appointed Sergeant, and served in several hard-fought engagements. While in the army his ability as an engineer and draughtsman was recognized, and he was detailed by Colonel—afterwards General—Ross, for duty at headquarters of the Army of the Cumberland, and for about a year was stationed at Lookout Mountain, engaged in the preparation of plans for various engineering works.

Upon his return from the war he engaged in business in Indianapolis, Ind., with his brother, and while there he met and married Miss Julia Halliday.

In 1867 he returned to New Haven, and entered the service of the New Haven & Derby Railroad Company as assistant engineer, but was afterwards appointed chief engineer, and as such had charge of the completion of the road.

In 1869 the office of City Surveyor of New Haven was created, and Mr. FOWLER was selected, without any solicitation on his part, by a committee of the Board of Road Commissioners, to fill the position. Such was his ability and integrity, that this choice has been ratified at every subsequent election by the unanimous vote of the board, regardless of its political complexion.

During his term of service as City Engineer, he has had charge of the construction of about 31 miles of sewers, under the system designed by

E. S. Chesbrough, C. E., besides several miles of pavements, a number of bridges and other engineering works. In addition to his work for the City of New Haven, he has prepared plans and estimates for complete systems of sewers for Northampton, Mass., and Danbury, Conn.

He had been a member of the American Society of Civil Engineers for several years, and always made it a point to be present at the meetings of the society whenever his official duties would permit.

He was prominently identified with the Grand Army of the Republic, having filled the chairs of Post Commander and Department Commander of the State, and at the time of his death was Quartermaster of his Post and a member of the National Encampment.

As an engineer he was very rapid and accurate in his work, fertile in resources, and far-seeing and of good judgment in planning public improvements. As a public officer he was always prompt and honest in the discharge of his duties, and courteous in his intercourse with everyone; as a superior officer, he was always ready to encourage and help his assistants, willing to overlook a fault, or offer commendation for honest effort; and, as a man, he was kindhearted and generous almost to a fault, with "charity for all and malice towards none."

Few men in New Haven were more widely known, none more universally respected and loved.

He leaves a wife and two children—a daughter about fifteen, and a son about three years of age.

ELECTIONS AND APPOINTMENTS.

ATCHISON, TOPEKA & SANTA FE.—The following circular has been issued: "Mr. A. A. ROBINSON, as Chief Engineer of this road and its leased lines (Leavenworth, Topeka & Southwestern; Manhattan, Alma & Burlingame; New Mexico & Arizona and the Sonora Railway), will have charge of the track, bridge, building and water service departments and of all matters pertaining to the office of Chief Engineer of these railroads."

GALVESTON, HARRISBURG & SAN ANTONIO.—Mr. A. N. TOWNE has been appointed General Manager of this road, and the position of General Superintendent is abolished. The road will hereafter be worked under the same management as the Central Pacific, and will include the Texas & New Orleans and the Louisiana Western roads, bringing under this management the entire line from El Paso, Tex., to Vermillionville, La.

"E. G. THOMPSON, Superintendent; Maj. JAMES CONVERSE will retain charge of the construction work, and as Chief Engineer of the El Paso, San Antonio and Houston divisions, headquarters at Houston. The line between El Paso and Sanderson will be known as the El Paso Division, of which JAMES CAMPBELL is appointed Superintendent and J. L. BONNER, Master Mechanic, headquarters at El Paso. The line between Sanderson and San Antonio, including branch to Eagle Pass, will be known as the San Antonio Division, of which W. G. VAN VLECK is appointed Superintendent, and J. J. RYAN, Master Mechanic, headquarters at San Antonio. The line between San Antonio and Houston, including branches, will be known as the Houston Division, of which H. FLANDERS is appointed Superintendent, headquarters at Columbus, and D. T. DAVIS, Master Mechanic, headquarters at Harrisburg. The line between Houston and Vermillionville will be known as the Louisiana Division, of which W. IRVIN is appointed Superintendent, and D. C. SMITH, Master Mechanic, headquarters at Houston. N. R. OLCOTT, Chief Engineer, will remain in charge of buildings and bridges on the Louisiana Division, headquarters at Houston. All other officers and agents are continued."

BRIDGE NOTES.—The Morse Bridge Co., in Youngstown, O., has secured the contract for an iron bridge over the Scioto River on State street in Columbus, O. The contract price is $16,400.

THE JETTY SYSTEM.

(From the Florida Daily Times.)

As the subject of improving river mouths by means of jetties or training walls is, at present, receiving considerable attention from the public in this vicinity, a short resume of the action of such works and the results that have been obtained in various places, may not be uninteresting to the general reader.

The mouths of most rivers on a sandy or alluvial coast are barred more or less effectually to navigation, by an accumulation of silt and debris brought down by the river waters or by the material of the adjacent shores of the sea or lake into which the river empties.

Rivers are thus seen to be of two classes, i. e., sediment bearing and non-sediment bearing. An example of the former is the Mississippi River, and the St. John's of Florida may be taken as a very good example of the latter.

The bars formed by sediment bearing rivers are by far the most difficult to deal with, as the bar is continually receiving reinforcements from the river itself.

In non-sediment bearing rivers, however, the main accessions to the bar at the mouth are derived from the wasting of the adjacent coast. Sometimes this is aided by a littoral or shore current in the ocean or lake which takes up the material washed from the shores by the waves and transporting it in a direction parallel with the trend of the coast line, fills up all depressions in the floor of the ocean and all channels or gullies whose currents are not strong enough to resist it.

In this manner the channels of deep rivers at their mouths are filled up and the river's waters are forced out in a fan-shaped manner and flow over the bar as water over the edge of a soup plate.

The theory upon which jetties or training walls are constructed at such places is simply, that by confining the outflowing waters between nearly parallel walls they will create and maintain, for themselves, a channel of about the same width and depth as they occupied before reaching the bar.

This theory is not new; on the contrary it was advocated and demonstrated to be correct more than a century ago, for in 1748 we find that in the harbor of Dublin, Ireland, jetties were constructed that gave a navigable channel of sixteen feet over the bar, when before there was only six feet. In Russia, the river Dvina has been improved in this manner for more than a hundred years, the depth being increased from six to eighteen feet, and no extension has been found necessary. Indeed, we have reason to believe that the Romans understood this principle and practiced it, and it is probable that this is what Horace refers to in Ode 1, Book III., when he says:

> "Contracta pisces aequora sentiunt,
> Jactis in altum molibus: une frequens,
> Cæmenta demittit redemptor."

In reviewing the effects produced by the construction of jetties for improving such bars as I have described, it is encouraging to find that in all cases where they have been properly located and built, they have proved successful.

The opponents of the jetty system have instanced the case of the Rhone, a river which discharges into the Mediterranean Sea, as a case where the application of jetties has failed to accomplish an improvement. An investigation of this case, however, disclosed the fact that the Rhone jetties were never properly located and built. Instead of extending across the bar to the deep water of the sea, as they should have done, these jetties ended about a mile from the crest of the bar. Without a doubt, had they been completed to deep water outside, they would have been successful. The permanency of jetties constructed of wood and stone has often been questioned. Regarding the action of the sea on such works, experience has proved them capable of withstanding the most violent storms when built large enough. The wooden mattresses in the foundation courses make a level foundation for the stone, and prevent unequal settlement. The brush fascines serve as sand catchers. It is found that soon after a mattress is sunk and loaded with stone that the sand and fine silt, aided by the action of the water, speedily fills up all the interstices between the logs and brush. In the course of a few months the stone is completely covered with a growth of shell-fish, such as barnacles, oysters, mussels, limpets and other molusks, which constantly increases, thus cementing the different fragments of stone and forming a homogeneous mass. The sand washes in and fills up the spaces between the stones, and in this way the wood-work below is completely covered and protected from the ravages of the sea worms, such as the *Teredo navalis* and the *Limnoria terebrans*.

It is well known that wood submerged continually in water is practically indestructible. The points of wooden piles driven into the bottom of the Rhine by the Roman engineers of Cæsar's army, in constructing a bridge across the river, about 70 years B. C., have lately been found in an almost perfect state of preservation, and indeed these evidences of resistance to decay are modern when compared with the wooden piles and household utensils found in the Lakes Geneva, Neufchatel, Constance, etc., of Switzerland, which were made by the lake dwellers of the Neolithic or Stone Age, an age antedating the Bronze Age, and older than written history, and which have survived many thousand years in the waters of the lakes.

In the following table I have arranged a list of a few river mouths and harbors that have been improved by means of jetties, with dates, depth on the bar before and after the improvements. This table contains only a few of the most celebrated cases.

In the United States the principal harbors requiring it on the Atlantic seaboard and the great lakes are now being improved in this manner, among which may be mentioned Newburyport, Mass., at the mouth of the Merrimack River, Charleston harbor, Brunswick harbor, in Georgia, Cumberland Sound, the mouth of the St. John's River, Florida, Mobile, Ala., Galveston harbor, Cavallo Pass, entrance to Matagorda Bay, Texas; Aransas Pass, Texas; Brazos River, Texas; Calumet River, Chicago, Ill.; Wolf River, Lake Michigan; harbor of Michigan City; Pultneyville harbor, New York, and many others.

An examination of the following table cannot fail to convince the most skeptical reader that the improvement of river mouths in this manner is no longer an experiment, but is wholly within the reach of engineering skill:

DATE.		Country.	Name of River or Harbor.	Original Depth.	Present Depth.
Previous to 1780		Roumania	Danube*	7 to 11	20
		Holland	Maes	0	18
		Prussia	Vistula	7	10
		"	Trave	7	18
		"	Warne	6	13
		"	Persante	4	15
		"	Wipper	4	13
		"	Prezel	12	20
		"	Stolpe	4	14
		"	Niemen	10	24
		Russia	Siban	6	16
		"	Dvina	6	18
		"	Windova	4	9
		"	Pernean	6	12
		Sweden	Nissa	5	12
		"	Koune	6	10
		"	Altra	6	9
		Denmark	Grenaa	5	13
1828		Russia	Oder†	6	24
1748		Ireland	Liffey‡	6	16
1861		India	Kurrachee harbor	14 to 15½	20 to 24
1875	During last 50 years.	United States	Mississippi**	9.2	30
		Egypt	Suez Canal††	0	24 to 26
		"	Suez Canal‡‡	0	26
		Holland	North Sea Canal §	0	27
		United States	Chicago, Ill.§§	3	15
		"	Milwaukee, Wis.§§	7	17
		"	Racine§§	2	14
		"	Michigan City§§	1	12
		"	Erie, Pa.§§	3	15
		"	Buffalo, N. Y.§§	V'y small	15

REMARKS.—* Ulina mouth. † Swine mouth of Stettiner Haff. ‡ Dublin Harbor. ‖ Layari River and several creeks. ** Originally 7.5 feet at low water. †† Port Suez. ‡‡ Port Said § Outlet of the Het IJ, an arm of the Zuyder Zee. §§ Aided by dredging.

J. FRAS. LEBARON,
Civil and Hydraulic Eng., M. Am. Soc. C. E.
JACKSONVILLE, Jan. 1, 1883.

THE DECAY OF BUILDING STONES.

At a meeting of the New York Academy of Sciences on the 20th ult., an interesting paper on "The Decay of the Building Stones of New York City" was read by Dr. Alexis A. Julien. Prof. J. S. Newberry presided. Dr. Julien's paper started out with statistics of the buildings of New York having stone fronts; 78.33 per cent. are brown stone, 8 per cent. marble, and 2 per cent. granite. Dr. Julien said that in foreign countries atmospheric influences on buildings had received considerable attention, but in modern Europe and especially Great Britain there is hardly a building that will be in existence in 1,000 years. No remedy had been found for the decay of soft calcareous stone, and Italian marble decayed rapidly wherever it was exposed. The days of the brown-stone fronts are numbered and a prominent architect has said they are of no more use in New York than so much ginger-bread. A number of brown-stone fronts here, less than ten years old, already look frightful. Fragments fell from the Lenox Library, constructed of Lockport limestone, before it was finished. The frieze is now decaying. The obelisk is exposed to the blazing sun and biting frosts, and will necessarily experience decomposition. The external agencies of destruction are various. There are chemicals, acids attacking the stone, carbonic acid from the atmosphere, and nitric acid, especially in the summer, when electrical phenomena are common. Stone is injured by the oxygen and ozone and the common salt in the air. Mechanical disintegrations of stone are caused by frost and variations of temperature of 100° in a year, and sometimes 70° in a day. The action of the wind alone, bearing particles of dust along with it, also has an effect. Dr. Julien found tombstones in Trinity Cemetery, mostly of red sandstone, dated 1681 and 1722, in fair condition, and he declared red sandstone to be vastly superior to brown stone. This was also true of Nova

Scotia stone, which does not decay so quickly. The only permanent protection to buildings must be brought about by mineral compounds in solution. Insurance men believe there is not a single fire-proof building in the city in which the stone will not crumble in a fire. The Capitol at Washington, made of Potomac marble, is crumbling, and nearly all the marble buildings of Italy are affected by disintegration. What will become of the obelisk is shown by the fate of the obelisk in Paris. In New York, the northern and eastern parts of buildings are affected by decay, while in England it is the southern and western sides. In the Mall at Central Park the freestone mouldings have had to be repeatedly recut.

The society indorsed a petition to Congress to remove all duties on specimens of minerals and fossils, whether imported for sale by dealers, or by institutions of learning, or by private collectors, so long as they are intended for cabinet purposes.

NATIONAL EXPOSITION OF RAILWAY APPLIANCES.

The Chicago Common Council has granted the commissioners the privilege of laying tracks through the Lake Park into the Exposition building for the convenience of exhibits of cars, locomotives and heavy machinery, also of erecting an annex at the south end of the present building.

Assurances have been received from London that an interesting collection of exhibits may be expected from England.

Parties are arranging to build and operate an electric passenger railway around the inside of the gallery of the main building during the exposition, the length of which will be one-third of a mile, and a model gravity road, to carry passengers also, will be operated from a point on the main floor to a point a hundred feet distant, on the west wall, thirty or forty feet above the floor.

More than half the amount of space at the disposal of the commissioners has already been applied for.

The following letter has been received by Secretary Talbott from F. Lange, of the Imperial German Legation at Washington:

"I am aware that a National Exposition of Railway Appliances will be held in Chicago and opened on the 24th of May. If there has not yet been given notice to the Prussian government, which controls a very great system of lines, I beg you to give me all the information about it in order that I may communicate the same immediately to my government."

Applications for space come from every state and territory and from most foreign countries in which railways are operated, and the complete success of the exposition is assured beyond question.

NATIONAL EXPOSITION OF RAILWAY APPLIANCES.

OFFICE OF THE SECRETARY,
CHICAGO, Jan. 25, 1883.

DEAR SIR —It is deemed very important that the National Exposition of Railway Appliances, to be held in Chicago from May 24 to June 23 of the present year, shall contain, among its other special features, as full a collection of old articles pertaining to railway building and operation, which shall represent by contrast with their modern successors the improvement of the past fifty years, as it is possible to obtain. An earnest effort will be made to secure such a collection of "old curiosities," representing every department of railway building and operation, and it is hoped that all receiving this circular, who possess information of the existence of any article or articles of this nature, will at once communicate with the undersigned.

In no way can the various stages or degrees of progress, which have marked the railway history of this country and of the world, be more satisfactorily illustrated, or the instructive features of this Exposition be made more valuable to railway men of every class, and interesting to the general public, than through such a collection.

It is believed that, in the older sections of the country especially, there exist many railway appliances which have long ago outlived all usefulness, except as historical landmarks, showing the progress of later years, and it is hoped tha this request may serve to bring them to light, and add a most interesting and valuable feature to an Exposition which promises to be a very important contribution to the practical and technical knowledge of this eventful century. Arrangements will be made for the transportation of all such articles to Chicago and return. Yours, very truly,

E. H. TALBOTT,
Secretary National Exposition of Railway Appliances.
GRAND PACIFIC HOTEL, Chicago.

CHICAGO & NORTHWESTERN.—This company is having surveys made for a line from Gladbrook, Ia., to Anamosa, about 90 miles. A line has also been run for an extension of the Maple River Branch from Holstein to Sioux City, about 50 miles. Some 10 miles of this extension is graded.

LONDON CORRESPONDENCE.

LONDON, Jan. 15, 1883.

The past week has been a rather eventless one for the engineering trades, if we except the news received by cable from your side referring to the passing of the shipping bill in a very liberal form. The question is of the utmost importance to our engineering industry, and a very light business is expected in all kinds of ship material and in ships suitable for the carrying trade between your country and foreign ports. At present the entire ship-building and engineering trades maintain an exceptional activity, but there are apprehensions that the great increase made to the tonnage of the world during the last two years may prevent this being restrained for any lengthened period.

The question of the employment of continuous brakes in France has been solved in rather an arbitrary fashion by the French Minister of Public Works, Mr. Ch. Hérisson. He has issued a circular specially recommending a particular form of brake—what is now known as the Wengar brake worked by compressed air, and it is stated a very defective modification of the Westinghouse brake, the sole merit it apparently possesses being that carriages fitted with it can run in trains fitted with the Westinghouse brake. Even if the charge is true that the French railway companies cannot generally be brought to use uniform kinds of appliances (some have been experimenting with the Smith Hardy vacuum brake, others with the Achard electrical brake, or the Westinghouse brake), the step taken by the Minister must appear irregular. Mr. Hérisson mentions in his circular that the difficulty experienced appears to him chiefly that several companies wish to adopt the American Westinghouse brake, but that this engineer after having accepted numerous contracts cannot now deliver in proper time.

The Manchester Ship Canal Project has passed a further stage. Mr. Adamson, the chairman of the committee, has handed over nearly a quarter of a million of money as a parliamentary deposit. The subscriptions to the guarantee fund of £1.000,000 reported to have reached the sum of £1,550,000 and the call of 20 per cent. is in course of payment. It is stated that the points upon which the objections had been lodged to the bill have been carefully considered by the parliamentary agents before the deposit was made. As regards the capital necessary to carry out the scheme there can be no doubt that it would be forthcoming the moment the bill became law.

THE IRON AND METAL MARKET.

There has been scarcely any change to note. American Pig is $21 to $25; Scotch Pig $21.50 to $25; Steel Rails in desirable orders can probably be had at a shade less than $40 at mill. Philadelphia quotations are, for Structural Iron, about 2.5c. for Angles; 3.3c. for Tees; 3.5c. for Beams, and 3.7c. for Channels; for Plate and Tank Iron, 2.5@2.6c. for Tank and Boat Plate, 3.5c. for Shell, 4.25@4.5c. for Flange and 5.5c. for Firebox; Wrought-Iron Pipe—Boiler Tubes are firmly held at 55 per cent. off, with a fair demand. Steam and Gas Pipe, 65@67½ per cent. off, and quiet; Railway Supplies—Pittsburgh prices, demand fair and improving; prices unchanged: Railway Spikes, 2.8c. per pound, 30 days; Splice bars, 2½@2¼c.; Track Bolts, 3.50@3.75 with square and 3.75@3.90c. with hexagon nuts.

NEWS OF THE WEEK.

PENNSYLVANIA AND NEW YORK CANAL AND R. R. CO.—This company is preparing to cut a double-track tunnel across the "neck" at and near Vosburg, 4 miles west of Tunkhannock, the county seat of Wyoming County, Pa. The tunnel will be straight, about 3,500 ft. long, exclusive of approaches, and will shorten the line 4 miles. Bids will be received for this work until Feb. 15, at the office of the Chief Engineer, Towanda, Pa.

BRIDGE AT QUINCY, ILL.—Efforts are being made to build a highway or wagon bridge over the Mississippi, at Quincy, Ill.

CAROLINA, CUMBERLAND GAP & CHICAGO.—Arrangements have been made to begin work near Aiken, S. C., on this projected road.

WATER-WORKS FOR UNIONTOWN, PA.—W. T. Kuhan, of Pittsburgh, has offered to construct and operate works at his own expense, provided the borough would pay $1,200 per year for 30 fire plugs. No contract has yet been made. Other parties also desire to build the works.

DEPOSIT & SYRACUSE.—It is proposed to build a railroad from Deposit, N. Y., on the Erie road, north by west to Syracuse, about 90 miles. The line proposed is about midway between the New York, Ontario & Western and the Syracuse, Binghamton & New York, and passes through some pretty rough country.

Kellogg & Maurice, in Athens, Pa., have a number of contracts for railroad and highway bridges on hand.

R. F. Hawkins & Co., of Springfield, Mass., have taken the contract to build the new bridge across Lake Champlain at Rouses Point, for the St. Johnsbury & Lake Champlain railroad. The bridge will be a pile bridge about 2 miles long, with two draw-spans, and will cost about $150,000. Work is to be begun very soon.

WATER-WORKS FOR ZANESVILLE, O.—Surveys for water-works for the above city are being made.

THE BASIC STEEL PROCESS.—Favorable progress continues to be made in practice with the Thomas-Gilchrist dephosphorizing process, as evinced by the recent returns of the output at the various European works using the process. The total number of these works using, or about to start using, the process is at present 32. Of these, there are 14 in Germany, six in France, four in England, four in Austria, two in Belgium, one in Luxemburg, and one in Russia. Besides these, there are 13 works, the proprietors of which have taken licenses to use the process, and where it will probably be adopted in course of a short time. Of these, there are nine in England, three in France, and one in Belgium. The total quantity of basic steel manufactured at the works where the process is in operation in the above countries during the month of October last, was not less than 46,537 tons, by 15 firms. The German makers stand first with an aggregate output of 25,170 tons by eight firms, or an average of 3,146 tons each. In England, however, the output was 9,500 tons by only one firm. Austria shows an output of 7,700 tons by three firms; Belgium 1,687 by one firm; Russia 1,270 tons by one firm, and France 1,240 by one firm. This output and the extent to which the process is being worked, would appear to indicate that, although barely out of its infancy, it is paying. It is only reasonable to expect, that with further practice and an increased output, the present cost of production will be reduced as is anticipated.

A NEW WATER-FILTER.—The problem of constructing a filter for steam users and manufacturers that should be able to deal with large quantities of muddy river and canal water, and should at the same time be capable of being easily and efficiently cleaned has been solved by the Pulsometer Engineering Company of the Nine Elms Iron Works, by the adoption of an elastic filtering material, which when compressed forms a compact bed through which the water percolates, but when released immediately expands, freeing itself from the accumulated dirt, and offering little resistance to the flushing current that is then sent through it in the opposite direction. The material employed is sponge contained in a cylinder, and normally compressed between the cylinder end and a piston. While the cleansing operation is being conducted the piston is alternately raised and lowered, the action on the filtering medium being similar to that ordinarily adopted in washing a soapy sponge; it is first allowed to absorb water until the pores are filled, and then the water is squeezed out carrying a part of the mud with it, the process being continued until the effluent water is clear.

SCHOOL HOUSE.—Norwalk, O., is about to build a school house at a cost of $60,000.

OPERA-HOUSE.—Minneapolis, Minn., will have a new opera house costing $60,000.

PUMPING ENGINE FOR ST. LOUIS WATER-WORKS.—The high service engine now being built in Baltimore for these works will be ready for shipment in a few months.

RAILROAD PROJECTS IN TEXAS.—The Galveston *News* says: The prospects of two more lines of railway from Dallas are flattering, and their construction is believed to be beyond mere conjecture. While the Gulf, Colorado & Sante Fe will undoubtedly run a survey to Paris, both from Fort Worth and Dallas, there can be but little question as to which route will be adopted. The St. Louis & Texas Narrow-gauge having secured all necessary depot grounds and subsidies in Dallas, will soon connect their main line with this city. Active efforts are being made respecting a northwestern road, and you may look for work to commence at any time in that direction. All the lines of railroads running into Dallas are doing a thriving freight and passenger business.

WATER-WORKS FOR MATTOON, ILL.—A note from this town says: The question of establishing an adequate system of water-works in this place is being vigorously agitated, and the Council already has under consideration a proposition from Tra-

vers Daniels, of Clarksville, Tenn. The city has never had any water-works, but it has been very lucky in regard to fires, and the citizens now think it is time to move in the matter.

SPENCER WATER COMPANY.—The Committee on Water Supply and Drainage of the Massachusetts Legislature has reported a bill incorporating the above company. Capital $200,000.

MIDLAND, MICH., WATER-WORKS.—These works have been formally tested and pronounced complete. The pumps have a capacity of 1,500,000 gallons per day. M. Walker, of Port Huron, is the contractor.

NORTHERN EXTENSION OF THE PHILADELPHIA & READING.—All the trestle work and bridges have been completed.

STONE CONTRACT LET.—The contract for the stone work on the West hotel at Minneapolis, Minn., has been let to Brainard & Co., of Chicago, for $100,000.

NEWCASTLE-ON-TYNE CANAL.—A scheme has just been set on foot to make a ship canal from the Tyne to the Solway Firth. The distance from sea to sea is about 80 miles, of which about a dozen are now navigable by large ships.

GLASGOW WATER SUPPLY.—It was mentioned at a late meeting of the Town Council of Glasgow, Scotland, that in the three weeks of the month ended Jan. 2 there were sent into the city no less than 89,190,000 gallons above the usual average of 38,300,000 gallons. This showed the enormous strain put upon the Water Commissioners, and it was satisfactory that they had been able to supply such a large quantity of water to the inhabitants.

COURT-HOUSE AND SCHOOL-HOUSE. — Benton, Cal., is talking of building a $50,000 court-house and a $30,000 school-house.

BRIDGE AT YPSILANTI, MICH.—The house at Lansing has passed bills authorizing the city of Ypsilanti to build a bridge over the Huron river.

SHOPS FOR PAN HANDLE R. R.—Plans have been filed at Columbus, O., for new shops to be erected by this company. Work will be commenced in the spring. The shops will be erected in the north-eastern suburbs of the city on grounds now owned by the city. The estimated cost of the shops and tracks, exclusive of tools, is $537,000. It is estimated that the proposed shops will be capable of doing the general repair work in connection with the Western Division of the P., C. & St. L., the Little Miami and the Eastern Division of the C., C. & I. C., and will also have capacity for building fifty engines, thirty-six passenger and 3,000 freight cars per year.

DETROIT, INDIANA & ST. LOUIS R. R.—This company has been incorporated in Indiana. Capital $2,000,000. The proposed line will extend from Fayette, O., to Bloomington, Ill., running through Fulton and Williams counties, Ohio; Steuben, Dekalb, Noble, Kosciusko, Fulton, Pulaski, Jasper and Newton counties, in Indiana, and Iriquois, Ford, Livingston and McLean counties, in Illinois. The length of the line will be 280 miles. The directors are Hiram Iddings, Owen Block, William Worden, John A. Singer, Samuel W. Oldfather, Amos T. S. Kist, Ancil B. Bare, Albert Tucker, Francis M. Platman, Washington Bybee, J. Dunbar and Horace Tucker.

BRIDGE OVER THE ALLEGHENY.—The New York, Pennsylvania & Ohio and the Allegheny Valley railroad companies have decided to jointly build a bridge over the Allegheny River at Frankton.

THE CHINESE AND THE ELECTRIC LIGHT.—The foreign settlement at Shanghai has for some time been lighted by the Brush system. The Chinese Governor of the district objected to its use and addressed a letter to the senior Foreign Consul requesting the removal of all the electric lamps. He has read, he says, in translations from European papers, that terrible accidents have arisen from electricity, and flatly refuses to permit the residents of Shanghai to be exposed to such dreadful risks. Hundreds of thousands of houses might be destroyed, millions of lives might be lost; even the walls of the city might be blown down if anything went wrong with the machines. He has strictly forbidded his own countrymen to use it, and has peremptorily ordered those who have already adopted it to discontinue it forthwith.

WATER-WORKS, PRINCETON, N. J.—The Princeton Water Company has contracted with the Warren Foundry and Machine Company for 360 tons of cast-iron pipe at $36.90 per gross ton, and with Tippett & Wood for the erection of a wrought-iron tank 20 ft. in diameter and 60 ft. high on an iron trestle 60 ft. high. The gates and hydrants have been ordered from the Eddy Valve Company. The contract for well and engine-house and pipe-laying will be advertised in a few days, and the works will be built immediately, in charge of J. J. R. Croes, C. E.

THE SUEZ CANAL.—The members of the Works Committee of the Suez Canal Company have unanimously adopted the programme referred to them by the directors. As the works will take several years to complete, the Committee has arranged them in order of importance, and consequently of execution, viz.: Rectification of the west bank of the channel of the outer port of Port Said; formation of a new basin at Port Said; widening of the Canal in the passage of the small Bitter Lakes; widening of the Canal between Suez and Kilomètre 152; doubling of the Ismailia station; embankment of Kantara station, and of the station at Kilomètre 133; rectification of the eastern curve of the Timsah station; also of the southern curve of the small lakes; also of the northern curve of El Guisr; also of the curve of Toussoum; widening of the Canal off Port Tewfik; deepening of the basin of Port Tewfik; and the annual continuance of the masonry work.

The Committee think these works will be adequate for the doubling of the present traffic, or 10,000,000 tons. In anticipation, however, of a still greater increase, they think it will be expedient, at a date which cannot be yet fixed, to take into consideration the idea of the cutting of a second channel, parallel to the present one. Such a second channel, definitively meeting all future exigencies, would involve negotiation for obtaining, besides the compensations foreseen, the land for such a channel and for the embankment of the stations at the ports.

RUSSIAN RAILROAD BRIDGE.—One of the Russian strategical railways, that of Ivangorod-Dombrovo on the Polish frontier, includes a stone bridge over the River Weis, and is to be commenced this spring and finished in October, 1884. It is to cost two millions of roubles.

DISTANCE INDICATOR FOR LOCOMOTIVES.—There are various cases in which an engine driver may have difficulty in knowing precisely what point he has reached, *e. g.*, in snowy or foggy weather or at night when wind has put out the signals. An instrument has been lately invented by a Sicilian, Signor Vito, which is meant to show the driver at any moment, with close approximation, the point reached and which also sets the whistle in action at a given point where special attention may be necessary. The first part, for indicating the length of line run, is an ordinary counter with three discs, each divided into 100 parts and traversed by a needle set in motion by the engine wheels. The first disc indicates 10 metres for each division, the second kilometres, the third 100 kilometres. For the second part Signor Vito uses a cord of a certain length which the reaction of a spring tends to wind on a drum. This cord passes between friction pulleys governed by the counter, so that its rate of winding on the drum depends on the progress of the locomotive. A spiral spring wound up and held by a peg is connected to the valve of the whistle. Suppose, now, the driver has to give special attention after running 100 kilometres. At starting, the counter needles being at zero, the driver winds round the peg a certain length of cord corresponding to the distance named (the cord having been divided into measured sections). During the journey the cord unwinds uniformly and when 100 kilometres is run this motion suddenly stops, but the peg yields to the pull and the liberated spring opens the whistle, which continues to sound till the driver coils the spring again and replaces the peg, whereupon he may set the apparatus for another indication.

CONTRACTS.—It is officially announced in Belgium that the specifications and drawings relating to various foreign contracts may be inspected at the *Musée Commercial*, Rue des Augustins, Brussels.

DANGEROUS CONDITION OF A BRIDGE.—As a traction engine was passing over Monk Bridge, Whitehall road, Leeds, a few days since, some of the plates gave way, and part of the engine went through the roadway. All vehicular traffic has since been stopped, thus causing great inconvenience to the residents of New Wortley and Holbeck, by the traffic having to be worked along more circuitous routes. This bridge, which now belongs to the Corporation, is stated to be too weak, and not at all equal to the strain put upon it. Some engineers think it ought to be rebuilt, and that if it is not made stronger some serious catastrophe will be the ultimate result. The bridge is an iron structure on the suspension principle, and was built from designs by Mr. Leather, C. E., at a cost of about £4,200. It has an arch of 112 ft. over the river, with two small land arches and an elliptical arch of 24 ft. spanning the Leeds and Liverpool Canal. Altogether it is 260 ft. long and 36 ft. wide. It was cast at the Bowling Iron Works, and was the first bridge on the "bow and string" principle, which originated in Leeds. It was constructed in 1857—and was freed a few years ago—the charge being formerly a halfpenny for foot-passengers.—*London Contract Journal, Jan.* 17.

EDINBURGH WATER SUPPLY.—The following report from Mr. Coyne, C.E., was submitted at a late meeting of the Edinburgh Town Council:—"During the month of December the few men employed were occupied in attending to general jobbing and repairs. There were 40 openings made in roads and streets, for the purpose of executing repairs, searching for burst pipes, putting on scour valves and changing hydrants, etc. The number of apparatus examined for checking waste of water was 10,908, of which 9,965 were found to be good, and 943 faulty or in a state of disrepair. The systematic house-to-house inspection had to be suspended during the storm, the water officers and inspectors being fully occupied both day and night in attending to the almost constant demand for turning off water where the service pipes were burst and premises flooded. The quantity of water sent into the city and district and places adjacent was on an average equal to 13,964,387 gallons per day, which represented 43 gallons per head per day to 324,800, the population supplied. The maximum quantity of water sent in on one day was 17,535,000 gallons, which represented about 54 gallons per head. This enormous consumption was due chiefly to deliberate waste and burst service pipes. During a great part of the month of December, but particularly during the storm, the vicious practice of leaving water apparatus constantly open prevailed over a large extent of the city and district, with the result that at least 5,704,000 gallons per day were wasted during the period of maximum supply, and about 1,600,000 gallons per day during the period of minimum supply. Indeed, in one district the pressure in the main-pipes was so reduced as to prevent the water rising to the top cisterns in the houses, while, at the same time, the parties who were thus deliberately wasting the water were persistent complainers of having no water for the pressure boiler. Instead of the 50 gallons per head during the storm, the supply has now been brought down to its normal state of about 36 to 37 gallons per head per day."

TRINITY AND SABINE R. R.—This Texas road is about completed. It runs from Trinity 67 miles west to Jasper on the Sabine river. Russell Harding is chief engineer.

GAS WORKS COMPLETED.—Fresno City, Cal., is now illuminated by gas. The works just completed are ample to supply a town of 15,000 population.

HOSPITAL FOR THE GALVESTON, HARRISBURG & SAN ANTONIO R. R.—This company has founded a railway hospital at Columbus, Texas. Every employé who is injured or disabled by sickness is remanded to the hospital and cared for by the best medical attendance until he recovers, when he receives a pass over the road to the department he was previously attached to. Last year 1,589 cases were treated, and the death record was restricted to twenty-seven names, and of that number six were admitted in an advanced stage of tubercular consumption. It has been contemplated by the Sunset management to establish their general hospital in Columbus, the site for which has been generally donated by its citizens, in a beautiful grove, five squares north of the passenger depot. A contract to this effect will probably be executed unless the citizens of San Antonio offer sufficient inducements to secure its location there. The building contemplated will be one of the finest in the State, having a front 264 ft. by a depth of 135 ft.; having a capacity of 200 beds, with an allotment of 1,860 cubic ft. of air space for each bed. It is divided into seven wards, each with independent ventilation, separate sinks, lavatories and bath-rooms, with all necessary foul air escapes and means for artificial ventilation in cases of necessity. Skillful assistants are dispersed along the entire line; and as soon as the hospital fund will justify the expense reception hospitals will be established at such intervals along the line as may be necessary for such treatment as may be required prior to the transfer of patients to the general hospital.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—Additional buildings and improvements to cost some $200,000 are about to be provided for this institution.

SEWERING FORT WORTH, TEXAS.—The city engineer will begin a topographical survey, preparatory to grades for sewers and permanent street improvements.

ILLINOIS, IOWA & NEBRASKA R. R. The road was incorporated in Illinois. The road is to be constructed from the City of Peoria, Ill., to the City of Quincy, Adams County, and to Sioux City, County of Woodbury, Iowa, with such extensions and branches as the interests of the company may from time to time declare. Principal business office to be at Chicago; capital stock $1,375,000. Incorporators—John D. Fonda, Fred W. Menke, of Quincy; Wm. Hill and John H. Finley, Warsaw; Henry A. Osborn, Chicago; David M. Kelly, Green Bay, Wis.; Wm. H. M. Sistar, Walter Scranton and Samuel Marsh, New York; Henry Ketchum, New London, Wis.

ST. LOUIS, FORT SCOTT & WICHITA R. R.—A large force is now grading this road from El Dorado to Wichita, Kan. The line will be completed to that point by July 1, next.

BRIDGE FOR RED WING, MINN.—The Minnesota Central has offered to build a bridge in connection with the city across the river. The bridge will be wide enough for two wagons to pass with railroad track in the center, similar to the government bridge between Rock Island and Davenport.

the bridge is to cost $250,000, $100,000 to be paid by the city, the company to keep the bridge in repairs for ever and furnish force to run it; the city to take toll if they desire.

GAS IN ILLINOIS.—A bill introduced in the Illinois Senate provides the following rates: In cities containing 100,000 inhabitants or more, $1.50 for each 1,000 cubic ft.; in cities of less than 100,000 and over 50,000, $2; in cities of not more than 50,000, $2.50, and in cities of not more than 20,000, $3.

THE STREETS OF NEW YORK.—It is clear that something must speedily be done to restore the streets to their legitimate uses. Under the pavements are laid pipes for the conveyance of water, gas, and superheated steam. The water pipes are the concern of the city. The gas and steam pipes belong to private corporations, which not only pay nothing for the privilege of occupying the streets, but which annually subject the tax-payers to large expenses required to make good the damage incurred in taking up pavements, digging trenches, and refilling excavations. Added to this expense and hindrance to legitimate business has come the newer danger and damage of explosions and eruptions—the result of careless and slovenly work in making and refilling excavations. Above ground the streets are impeded and disfigured by the erection of forests of unsightly and ungainly poles for the carrying of wires for telegraph, telephone, and electric-light purposes. Many houses and public buildings are surrounded by a net-work of wires, so that in case of fire it would be impossible to reach the burning structures by any known means. To crown all, the elevated railway companies have been allowed to convert some of the streets and avenues into a species of above-ground tunnels, into which water, cinders, and rubbish are indiscriminately dumped.

Great outcry is made, now and again, over the casual and infrequent use of the streets and sidewalks by merchants, business houses and hucksters. But rich corporations, deriving their powers from a Board of Aldermen, and paying not one penny for their privileges, have contrived to undermine the streets and to make life and ordinary traffic above ground a continual burden. The dangers from telegraph wires above and gas and steam pipes beneath add new terrors to living in New York. Something must be done to mitigate these perils, restore the thoroughfares to the safe occupancy of lawful traffic, and reimburse the city for the frightful expenditure annually incurred in repairing the damages inflicted by irresponsible miners and diggers. The telegraph and other wires must come down. The forests of masts and net-work of iron wires must disappear. And the companies who mine the streets must pay for their privileges and be taxed to meet the expenses which they entail upon the city.—*Times.*

BRIDGE FROM SAN FRANCISCO TO ALAMEDA POINT, CAL.—The practicability of building this bridge is again being discussed by citizens of San Francisco. It was estimated that the whole work would not cost more than $5,000,000, including the railroad bridge, roadway and walk. One span 500 ft. wide and 100 ft. high would be required in this bridge. Five years would probably be consumed in constructing it.

AN AUSTRIAN BELT ROAD.—VIENNA, Jan. 31.—An imperial concession has been granted to a firm of English contractors for a railway, by which all the Vienna railways will be united by branch lines and a circular railway.

SEWERAGE FOR GALVESTON, TEXAS.—The question of properly sewering Galveston is again being agitated.

CANDLE POWER OF GAS IN CONNECTICUT.—From the annual report of the state gas inspector, Chas. W. Hinman, for 1882, we take the following candle powers. English candles made expresly for the purpose were used in testing. The name of the place or company is followed by the candle power of the gas: Boston, 19.13; Brookline, 17.10; Cambridge, 16.52; Charlestown, 16.61; Chelsea, 17.66; Dorchester, 16.78; East Boston, 18.34; Fall River, 16.55; Haverhill, 16.87; Holyoke, 17.43; Jamaica Plain, 17.60; Lawrence, 17.42; Lowell, 17.67; Lynn, 16.66; New Bedford, 17.13; Newton, 16.57; Roxbury, 18.63; Salem, 17.38; South Boston, 17.95; Springfield, 17.22; Taunton, 17.35; Worcester, 16.22. The poorest gas in the state is in Malden, North Attleboro and Webster, in each of which places the record is 16.40. Only six places in the state rank higher than Boston. These are Southbridge, 22; Great Barrington, 27.1; Amesbury, 27.3; Leominster, 28.8; Lexington, 30.2; and Chicopee Falls, 40.4. The report speaks in detail of the impurities found in the gas of the different companies.

GAS-WORKS AT KEENE, N. H.—This company is about to rebuild its gasometer, thereby increasing the storage capacity of the works over 16,000 ft.

WATER-WORKS AT SPENCER, MASS.—Water from Shaw pond was introduced into Spencer on the 30th ult. A pressure of 83 lbs. was obtained at the depot.

LAND SLIP IN SWITZERLAND.—A very serious landslip occurred on the 2d ult., on the Paris & Lyons Railway, near the French frontier. On the night of that date an old railway watchman, who lives in a cabin between the station of Collonges and the long Credo tunnel which runs under the pass to Bellgarde, felt his house shake and heard a portentous noise like thunder. Feeling sure that something was wrong, and knowing that the train which leaves Geneva at midnight was due, he ran along the line, placing detonators on the rails as he went. By this device he succeeded in stopping the train, and not a minute too soon, for the noise he had heard came from an earthslip, which carried 200 meters of the permanent way bodily into the Rhone, whither, but for the old man's presence of mind, the train must inevitably have followed it. The Rhone hereabouts runs through a narrow, rocky gorge, bounded on one side by a lofty spur of the Jura, whereon stands the picturesque Fort de l'Ecluse, and on the other by the precipices of Mont Vuache, along a ledge of which runs the railway from Bellegarde to Evian. The line from Geneva before entering the great Credo tunnel passes through a short one immediately below the fort. At half-past 4 o'clock on Wednesday morning a great mass of earth fell from the mountain directly above the smaller tunnel, and completely blocked the course of the Rhone. At noon the tunnel itself fell in with a report that was heard for miles. The water accumulated behind the barrier with frightful rapidity, and if it had gone on gathering, even for a day or two, the consequences would have been frightful—the valley of the Rhone, as far as Lyons would have been swept as by an avalanche. As it was, the dam burst a few hours after the second earthslip, and no great harm has been done. But the danger was still far from being over. An earthslip occurred nearly every hour; the road was destroyed for miles, and there were even fears for the integrity of the fort; as for the railway, a new line will probably have to be made and carried round the other side of the mountain.

GENEVA, Jan. 10.—The railway block, caused by the earthslip at Fort de l'Ecluse continues, and occasions serious inconvenience here. The Paris & Lyons Company refuse to grant tickets either to or from Lyons; and besides the delay in the arrival of the mails, the stoppage of traffic has already entailed a rise in the price of prvoisions and fuel.

ANNUAL REPORT OF THE HOLYOKE (MASS.) WATER COMMISSIONERS.—The annual report of the Water Commissioners shows that during the past year 1,091 ft. of 8-in., 2,790 ft. of 6-in. and 1,835 ft. of 4-in. cast-iron pipe have been laid; 306 ft. of 1-in. and 159 ft. of ¾-in. wrought-iron pipe have been added. The length of cast-iron mains is 22 miles 5,053 ft. of cast-iron pipes and 4 miles 2,227 ft. of temporary wrought-iron pipes, making a total length of 27 miles 2,002 ft. of supply mains. The number of new service pipes is 102, making a total of 1,493. Eighteen new gates have been put in, making in all 145. There are 177 hydrants, 12 having been added the past year. Private hydrants are owned by the manufactories. The number of meters now in use is 105, and the value of metered water for the year was $9,839. The quantity measured was 114,718,500 galls., making the daily average consumption 314,297 galls. The cost of construction was $336,446. The commissioners consider the year one of unusual prosperity, showing a gratifying gain in the receipts and water rents. Referring to the water supply, they think the city council should authorize them to take such steps, as, in their opinion, the present and future needs of the city may demand and purchase all water-courses that may be procured for the use of the city. They are fully of the opinion that the time has come for a material reduction and revision of the present water rates. It can now be made without affecting in any manner the efficiency of the department or endangering the sinking fund. The receipts for the past year were: Balance from 1881, $817; water rents, $51,908; interest on meters, $796; service pipes, $965; sundries, $1,421; total, $55,908. The expenditures were: Interest on water bonds, $15,000; extension of main pipe, $8,654; extension of service pipe, $1,581; repairs on main pipe, $351; repairs on service pipe, $747; hydrants, $586; reservoir, $3,906; meters, $848; supervision, $1,007; inspection, $787; bonds, 282; shop, $405; office, $1,418; Bagg farm, $3,300; sinking fund, $16,400; sundries, $884; cash on hand, $272; total, $55,908.

HARTFORD & HARLEM.—Chief Engineer Bryson, of this proposed road, has prepared an estimate of its probable cost. Including equipment, his estimate is $8,520,000. But if the road connects with the New York & New England at New Britain, eight or nine miles of track and $350,000 can be saved. The road will be double-tracked with steel rails, the bed 30 ft. wide through cuts, and 25 ft. on embankment at sub-grades. The cost of steel rails is based at $50 a ton, as the present exceptionally low price of $40 is not expected to last. The bridges will be of iron, and there will be but one draw-bridge, which will cross the Housatonic River. The Saugatuck is to be spanned by a high-grade viaduct, 83 ft. above high tide. The enabling act which will come up before the Connecticut Railroad Committee provides that mortgages may be made to one or more trustees, to be approved by the Governor. This is similar to the New York & New England Railroad's arrangement. This arrangement is necessary, as in Connecticut to all such papers the State Treasurer and his successors in office are made parties; but, as a similarly-worded mortgage could not be given in New York, in the present instance the trustees and their successors are to be named. No special privileges in relation to bonds are asked.

THE FALL OF A BRIDGE AT BROMLEY.—Colonel Yolland has reported to the Board of Trade upon the fall of the Ivy Bridge over the London, Chatham & Dover Railway, between Bromley and Bickley stations, by which seven persons out of eight who had taken shelter in a hut standing under the southernmost arch of a bridge were suddenly killed on Nov. 23. He says: "The failure of the Ivy Bridge was due to a subsidence of the north pier, between the down main line and the gasworks sidings. The base of the pier appeared to have passed through the footings on to soft yellow clay, and then commenced to slide northward on some blue clay, so that the base of this pier had moved laterally to the north about twelve inches and had sunk vertically about fourteen inches. I think it probable that the subsidence of the north pier, after having stood for about twenty-four years without exhibiting any weakness of any kind, may have been facilitated by the removal of the earth under the north arch, and that the water during a somewhat wet season had passed down to the clay under that arch, softened it, and permitted the clay to be pushed upwards, lifting up the rails of the gasworks siding to the extent of about four inches, and allowing the north pier to settle down and then slide towards the north. I attribute the fall of the south pier and south arch to the vibration caused by the running of the traffic on the up line, as it will have been seen that it fell, without apparently giving any warning whatever to the parties who remained at the bridge thirty-two minutes after the running of the traffic had commenced, and within five minutes of the passing of the first down train at 6:47 a. m. It is greatly to be regretted that steps were not taken to enforce the orders of the inspector of permanent way (Mr. Archer), that no persons should be permitted to go into the hut under the south arch. I consider that great credit is due to the ganger of platelayers, E. Pearce, at having so early as eleven o'clock on the morning of the 23d November discovered that something was wrong with the bridge, and enabled steps to be taken for the protection of the traffic along the line."—*Contract Journal.*

APPLIED MATHEMATICS.

COMPLEMENT OF AN ANGLE.—Difference between it and a right angle.

SUPPLEMENT OF AN ANGLE.—Difference between it and two right angles.

The SINE OF $1'' = \frac{2\pi}{360 \times 60 \times 60} = 0.000004848$

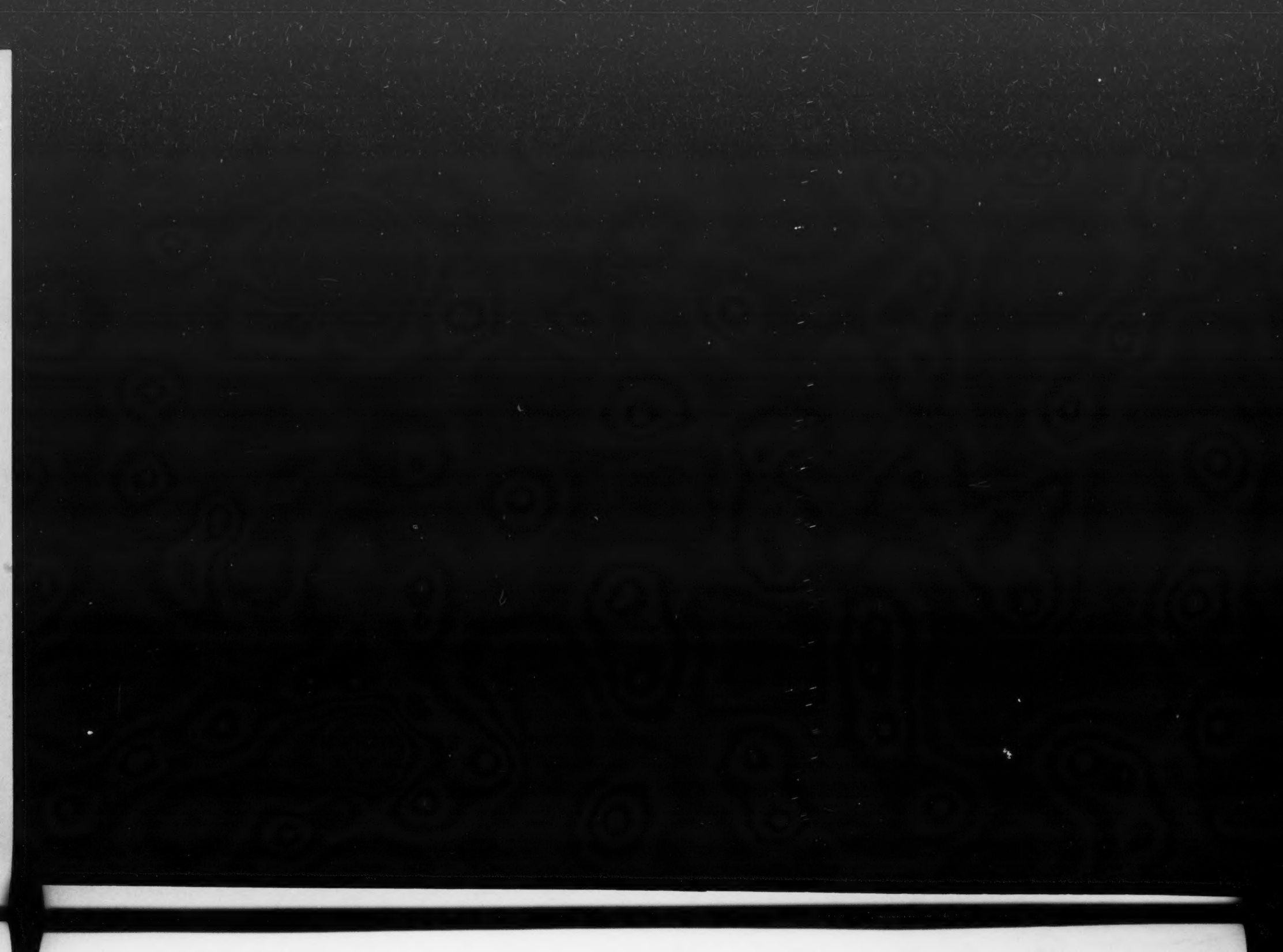
or sine $1'' = \frac{1}{206265}$

$\therefore A'' = \frac{A}{\text{sine } 1''}$, and it is by means of this equation that the circular measure of angles is reduced to degrees, minutes and seconds, and *vice versa*, in treatises on astronomy.

RELATIONS BETWEEN SIDES AND ANGLES.—In a right-angled triangle, either side is equal to the hypothenuse, multiplied by the sine of the opposite, or cosine of adjacent angle; and in the same, either side is equal to the other multiplied by the tangent of the opposite or cotangent of the adjacent angle; also any two sides of a plane triangle are as the sines of the opposite angles.

Area $= \frac{1}{2} b c \sin A$, where b and c are the sides, and A the included angle.

POINTS OF THE COMPASS.—In questions of navigation and marine surveying, the position of points and the direction of lines are generally referred to the *points of the compass.* The quadrant is divided into eight equal parts, each of which is called a *point;* the points are subdivided into half and quarter points.

One point = 11° 15′
A half point = 5° 37′ 30″
A quarter point = 2° 48′ 45″.

The points of the compass are sometimes spoken of as so many points to the right or left of north; thus: N. E. by E. is said to be 5 points right of north; W. by N. is 7 points left of north, and so on. When half and quarter points are spoken of, for for example: 3½ points right of north, or 5¼ left of north, they are represented thus, N. E. by N. ½ E., and N. W. by W. ¾ W.; or also by N. E. ¼ N. and W. N. W. ¼ N.